

THE 1493. m 58.  
ATTAC and DEFENCE  
OF  
FORTIFIED PLACES.

In three PARTS.

CONTAINING,

- I. Preparations for, and Operations of an Attac, from the Beginning to the End, in a regular and easy Manner.
- II. Preparations for, and Defence of every Part of a Fortification, with all necessaries for a good Defence.
- III. A Treatise of MINES, explaining the Manner of making and loading them, with Tables of the proper Charges and Dimensions of the Cubic Boxes for loading from 50 to 640 Pounds of Powder for their Charges, deduced from a new Theory.

For the Use of the Royal Academy of Artillery at *Woolwich*, and all concerned in the Art of War, by Land or Sea.

---

Illustrated with Twenty-five large Copper-plates.

---

By JOHN MULLER,  
*Professor of Artillery and Fortification.*

---

The SECOND EDITION,  
Corrected and very much Enlarged, with new Tables, &c.

---

L O N D O N:

Printed for J. MILLAN, near *Charing-Cross*, 1757.  
[Price Six Shillings.]







To his ROYAL HIGHNESS,

*William Duke of Cumberland,*

Captain-General and Commander in Chief  
of all his Majesty's Forces, &c. &c.  
&c.

S I R,



THE favourable Attention and  
generous Protection with which  
your Royal Highness has con-  
stantly honoured those who  
have used their best Endeavours  
to promote the Knowledge of any Branch  
of the Art of War, encourages me to pre-  
sent this Work to your Royal Highness,  
whose Genius and Application has made  
you the most competent Judge, as your  
high

iv *DEDICATION.*

high Birth and Command, claim the Patronage of such Performances.

My Intention is to render the Knowledge of this important Part of the Art of War intelligible.

And that it may meet with your Royal Highness's favourable Approbation and Acceptance, is the highest Ambition of,

*Your* ROYAL HIGHNESS'S

*Most Devoted*

*and most Humble Servant,*

JOHN MULLER.

Royal Academy of Art-  
tillery at *Woolwich*,  
July 20th, 1757.





## P R E F A C E.



**I**F, in the Art of War Courage alone was sufficient, a Treatise on this Subject in *England* would be superfluous; who from the lowest to the highest Subject are celebrated for this Virtue; but as it oft happens, that Enemies that dare not appear in the open Field, may retire into fortified Places, and there by Art and Stratagems destroy those Troops which before they durst not Face. For which Reason this Work was compiled, to furnish Means to such brave Men to avoid engaging on disadvantageous Terms, and to excite in them a Desire to apply their natural Genius to the Knowledge of all the different Occurrences which happen in their Station during the Course of a War, how to defend themselves, or to attac an Enemy with Advantage, and to save Lives so much as possible, in conducting the Works of a Siege with Skill and Prudence. There is no Part of the Art of War that requires more Capacity, Knowledge, and Judgment. The Success of a Battle is oft owing to Chance; a first Firing doing more Execution on



one side than the other, an advantageous Situation, a Party flanking the Army unperceived ; some extraordinary Action performed by some Men or Officer ; a sudden Wind or heavy Rain in the Face of an Army ; a pannick, Terror, or in short any unforeseen Accident, may contribute to the Gain or Loss of a Battle, and that oft on the Side who had least Reason to expect it.

History, ancient and modern, furnish so many Examples of this Kind, that it is needless to enumerate them. But when required to attac an Enemy in a Place strongly fortified, or when the Fortune of War obliges a General to defend himself in such a Place, against a numerous Army well provided, who find Means to approach the Works under Cover, beat them down with their Cannon, or blow them up with Mines, and ruin all their Defences ; it is then that Courage and Fortune are obliged to submit to Knowledge and Experience. There have been many brave Officers, provided with a good Garrison, and every thing requisite to make a brave Defence, who, thro' want of a competent Knowledge, were not able to preserve a fortified Place to their Prince or Nation, or to take one ; when, on the contrary, Men endued with less Bravery and more Knowledge, have succeeded in their Undertakings. Courage is undoubtedly a necessary Ingredient in the Composition of a Soldier, therefore every one should feel his Pulse well before he enters into this Way of Life, it being a Qualification not to be acquired. Nor is Experience alone sufficient to form a good Commander ; for the Situations and Constructions of Places are so different, and the Times and Occurrences so various, that it is impossible an Officer should, with the bare  
Experience

Experience of a few Sieges, be in a Condition to act with all the Conduct and Prudence necessary at any other Time, when perhaps every Part should be done quite differently from what he might have seen before.

Let us suppose a General endued with great Bravery, but unacquainted with the Art of attacking and defending fortified Places, enters an Enemy's Country, and after having committed some Ravages meets the Army of his Adversary and defeats it; which however is an Advantage not so easily gained, since, if his Enemy is a wary and prudent Commander, but inferior in Strength, he may possibly avoid an Engagement; but what Benefit will he reap from his Victory, if his Adversary retires into some strong Place, which he knows not how to attack and carry without the Loss of the best Part of his Army? Should he advance farther into the Enemy's Country, and leave strong Places behind him, he will run the Risk of being surrounded on every side, or having his Convoys of Ammunition and Provision cut off, whereby his Army will be reduced thro' Famine to retire; and that perhaps with Shame and the Loss of a considerable Number of Men, to no Purpose, notwithstanding his having been victorious at first.

It may be said, that the Engineers will supply his want of Knowledge, by informing him which are the strongest and the weakest Parts of the Place, how and in what Manner it is to be attacked, how the Approaches are to be made and carried on: This is certainly their Duty, and they ought undoubtedly to acquit themselves in the best manner they are capable; but how oft happens it that the Engineers are as deficient as the General? how

will he then proceed, or how can he judge of their Ability? The consequence will be, that a great part of the Army will be destroyed in an useless manner, and the General's Character will suffer, if the Success does not answer, and not they.

On the contrary, if the Engineers are duly qualified, in all respects, to answer what is expected from them, will the General know himself well enough to submit entirely to their Advice and Understanding, and regulate his Conduct according to their Judgment? A Task more difficult to an ignorant Person who is brave, than to one less so.

If a General, after a Defeat, is obliged to shut himself up in a fortified Place, and is there attacked by a superior Force, it will not be in his Power to make a good Resistance, if he is unskilled in the Manner of defending Places; all the great Expence a Prince or Nation is at in fortifying it, will not serve to secure the Country from Danger, if he is obliged to retire from one Place to another, so fast as the Enemy advances; and if he undertakes to make any Resistance, will expose the greatest Part of his Army to Destruction for no purpose, and the Country still left to the Mercy of the Conqueror. It is not the Loss of a Battle, an Accident the greatest General is liable to, but his Ignorance in defending himself in fortified Places, which he was obliged to abandon shamefully to the Conqueror, that will be an eternal Reproach to him.

Fortifications are now become almost as numerous as Towns, that it is impossible either to preserve a Country or make a Conquest, without being acquainted with the Art of Attac and Defence; wherefore it is of the greatest Importance to an Officer to be well instructed therein, since every  
one

one from the lowest to the highest has a Chance, or at least Hopes to become chief Commander one time or other; besides, every one is liable to be intrusted, in the Course of a War, with some Post or other, either to secure Convoys, or to annoy the Enemy, or prevent them from plundering the Country by Parties, wherein if they acquit themselves with Conduct and Prudence, it will be a sure road to Preferment, and acquire them a lasting Applause.

The celebrated *Vauban* was the first that made any considerable Improvements in this Part of the Art of War; he not only described the Manner of attacking Places in general, but also entered into every minute Particular that may happen, during the whole Course of a Siege, according to the different Circumstances, Times, and Occasions. Before his Time single Approaches only were made, fortified with a few Redouts to support the Workmen. But as this way of approaching did not embrace the whole Front attacked, the Besieged had Opportunities to Sally out and fall upon the Workmen and their Guard on every Side, drive them out of their Works and destroy them, by which means a Place but moderately fortified was able to withstand an Army a considerable Time, and oft until they were relieved, or the Badness of the Season obliged the Besiegers to retire.

But since *Vauban* has invented the Parallels or Places of Arms, and the Ricochet Firing, to which may be added the numerous Artillery with which Armies are now provided, the Art of Attacking is rendered so superior to that of Defending, that those Places which were formerly esteemed impregnable, can scarce stop a victorious Army a Month: And  
nothing



nothing but great Garrisons, and large Places well fortified, and provided with a sufficient Quantity of Artillery, and every Necessary for a good Defence, can have any Chance for making a tolerable Resistance. For by joining two Attacs with these Parallels, and the making half Parallels or Places of Arms between the second and third Parallels, the Besiegers can always oppose a greater Number of Troops against the Besieged, than they can, and by that means are able to prevent Sallies from the Garrison, or if they make any, drive them back with considerable Loss: And by means of the Ricochet Batteries, the Troops placed behind the Parapets are so much exposed to the Fire of the Besiegers as if there were none.

As *Vauban* has treated this Subject in so full and ample a Manner as could be expected, the Reader may be surpris'd that I have not rather given a just Translation of his Work than wrote a new one. This is what I intended at first, but several Reasons have determin'd me to the contrary. The Order and Method persued by that Author did not appear so well chosen as could be wished; such as treating of the same Subject in different Places; several Improvements have been made since his Time; which, tho' not very considerable, yet sufficiently deserve not to be neglected; he likewise supposed the Reader to be acquainted with the common practice of Engineering, which I presume not to be the Case of our Military Gentlemen in general; wherefore particular Care is taken in this Work to omit nothing that may render the Subject intelligible even to the meanest Capacity, so as to make it of general Use to all Readers, without being oblig'd to have any other previous Knowledge than  
that

that of understanding the Plans of Fortifications, without which it would be impossible to explain the Subject.

This Work is divided into three Parts; the first contains the Attac, the second the Defence, and the third the Manner of making Mines. The first begins with the necessary Preparations previous to a Siege, and then every Part of the Attac is distinctly treated of from the Beginning to the End, with the manner of tracing the Plan of the Attacs on Paper at first, and thence transferring it to the Ground; the Manner of placing and making the Batteries is also particularly explained; in short, nothing material is left untouched, which may in the least conduce to the full understanding the Subject.

In the Second is given every Thing that relates to the Defence of Places, beginning with the Garriſon, Ammunition, and Provision a Place ought to be provided with in respect to its Bigneſs and Strength, and the necessary Preparations in general previous to the Siege, to put it in a Condition of resisting ſo long as the Nature of the Place will admit of. I have ſomewhat differed in the Estimate of Troops and other Neceſſaries, from M. *Vauban*, on account that the Beſiegers are now more numerous, and provided with much more Artillery than in his Time. After this are given the Particulars of the proper Defences peculiar to each Work, wherein I have inſiſted much on the Defences of Forts and Caſtles, not omitting Churches and Farm-houſes, which are ſometimes of uſe to place ſmall Parties in, either to annoy the Enemy, or to prevent their annoying the Army, or making Inroads into the Country to raiſe Contributions. It likewise  
oft

oft happens that a Party is surprized by a superior Force, who to prevent their being taken may be obliged to retrench themselves in the best Manner they can in such Places: For which Reason I suppose it will not be altogether uselefs to shew how such Places, however insignificant in themselves, may resist for some Time a superior Force, especially if that Force be unprovided with Artillery; and as this Kind of Party-fighting doth more frequently happen than Engagements of whole Armies, if well managed they may prove of great Advantage in the End to an Army, tho' inferior to their Enemies.

The Third and last Part, contains a Treatise of Mines, more compleat than any hitherto extant, the Principles of which have been deduced from a Multitude of Experiments, made by M. *Belidor*, formerly Professor of the Royal Academy of Artillery at *La Fere*; and others, as Mr. *De Valliere*, Lieutenant and Inspector General of the Artillery, and Mr. *Mailgrigny* an old experienced Engineer. Their different Sentiments upon this Subject are candidly discussed, on the Result of which, and our own Experience, this Theory is formed; and to shew its Agreement with the Practice, several Examples are given, by which it appears to answer as near as can be expected from the Nature of the Subject.

M. *Vauban* has indeed treated very largely upon Mines, in his Memoirs of the Attac and Defence of Places: But as in his Time the Subject was in its Infancy, and not brought to that Degree of Perfection it is now arrived at, it is not to be presumed that he could have given all that may be said of Mines. Besides, the great Number of Experiments

periments made since his Time at *La Fere*, most of which I was an Eye-Witness to, has opened a much larger Field for Speculation.

Though M. *Belidor* was the chief Director of the Experiments made at *La Fere*, yet in his Memoirs upon this Subject, not yet printed, he has built his Theory upon an Hypothesis that may with reason be contested. For notwithstanding I had found, by measuring several Excavations of Mines, that their Figure is nearly a Paraboloid, he nevertheless rejects this, and makes use of quite another, whereby the Charges of Mines are determined.

It is certain that the World is obliged to him for exploding the old Errors, that the Diameter of the Base is always double the Line of least Resistance, or the Depth of the Mine; and when a Mine is loaded with a greater Charge than necessary, instead of producing a proportional Effect, that it makes only a narrow Hole or Pit: This has been the Opinion of all the Miners and Engineers before his Time; and so long as this Error subsisted, it was impossible to bring the Theory to any Perfection; since, according to this Notion, a Mine whose Diameter of the Base is 80 Feet, must be 40 Feet deep, which is not always possible; and when it may be done, would cost immense Labour, and some thousand Pounds of Powder more than is necessary, as I have shewn in this Treatise. This Work concludes with three Tables, the one computed by Mr. *De Valliere*, and the other two by me, and the Charges of Mines of the same Openings are compared, by which appears the great Advantage my Theory has above that of others.

Before I conclude, I cannot without Ingratitude omit to mention that excellent Work of M. *Le Blond*,



*Blond*, Professor of Mathematics to the Pages belonging to the King's great Stables, called *Elemens de la Guerre*, to which I am particularly obliged for the Order in which this Subject is treated ; and I have not scrupled to use some Passages of his where I found them useful : The Capitulation, inserted at the End of the Defence, is entirely from his Book, which I recommend to those who understand *French*, as being treated with more Clearness and Elegance than any other Work of the Kind.



# C O N T E N T S.

**T**ERMS used in this Book Page 1.

## P A R T I.

Attac 7, Stores			9	
Stores requir'd for a Month's Siege			10	
Investing Place		—	11	
Circumvallation Line		—	14	
Bridges of Communication			18	
Gates and Sally-Ports		—	19	
Park of Artillery	—		ibid	
Line of Countervallation		—	20	
Preparation for { the Attac }	—	—	21	
To Construct { on Paper			22	
Observations		—	25	
Properest Place for making Attacs			29	
Opening the Trenches		—	35	
Batteries placed before the first Parallel		—	40	
Construction of Batteries			43	
Saps 47, Parallels 51, Sallies		—	52	
Lodgment on the Glacis and taking the Covert-way			56	
Mines	—	—	60	
Attac of { the Covert-way }		Sword in Hand	64	
Batteries on {		—	66	
Descents and Passages over Ditches		—	69	
Attac of the { Ravelin			73	
{ Bastion			76	
Mines under the Bastion and Ravelin			80	
Recapitulation	—	—	84	
Attac of a Place	{ fortified with a	Crown, or Hornwork	86	
		Second Covert-way	89	
		Detached Redouts	72	
		Lunettes, Tenaillons or Counter-Guards	93	
		Cavaliers	104	
		Faus-Bray	98	
		Tower Bastions	100	
	{ situated	Ramparts without Bastions, in the ancient Manner, and covered with out-works in the Modern		103
		{ on {	an uneven Ground	107
			a Hill	115
		{ near {	a Great River	111
			the Sea	118
				How

*Blond*, Professor of Mathematics to the Pages belonging to the King's great Stables, called *Elemens de la Guerre*, to which I am particularly obliged for the Order in which this Subject is treated ; and I have not scrupled to use some Passages of his where I found them useful : The Capitulation, inserted at the End of the Defence, is entirely from his Book, which I recommend to those who understand *French*, as being treated with more Clearness and Elegance than any other Work of the Kind.



# C O N T E N T S.

## T E R M S used in this Book

Page 1.

### P A R T I.

Attac 7, Stores	9
Stores requir'd for a Month's Siege	10
Investing Place	11
Circumvallation Line	14
Bridges of Communication	18
Gates and Sally-Ports	19
Park of Artillery	ibid
Line of Countervallation	20
Preparation for { the Attac } on Paper	21
To Construct { }	22
Observations	25
Propereft Place for making Attacs	29
Opening the Trenches	35
Batteries placed before the first Parallel	40
Conftitution of Batteries	43
Saps 47, Parallels 51, Sallies	52
Lodgment on the Glacis and taking the Covert-way	56
Mines	60
Attac of { the Covert-way } Sword in Hand	64
Batteries on { }	66
Descents and Passages over Ditches	69
Attac of the { Ravelin } 73	
{ Bastion } 76	
Mines under the Bastion and Ravelin	80
Recapitulation	84
Attac of a Place { fortified with a { Crown, or Hornwork 86	
{ Second Covert-way 89	
{ Detached Redouts 72	
{ Lunettes, Tenaillons or Counter-Guards 93	
{ Cavaliers 104	
{ Faufs-Bray 98	
{ Tower Bastions 100	
{ Ramparts without Bastions, in the ancient Man- 103	
{ ner, and covered with out-works in the Modern	
{ situated { on { an uneven Ground 107	
{ { a Hill 115	
{ near { a Great River 111	
{ { the Sea 118	
	How



# CONTENTS.

How to prevent Succours being thrown into a Town Besieged	119
Remarks on the Defence of Lines	124
Raising of a Siege	126
Attacs of Forts, Castles or Houses	128
Surprising large Places	131
Taking a Place by Escalade	136
Remarks on Places taken by Surprise	139
How and when a Siege may be accelerated	140

## PART. II. DEFENCE.

Defence	143
Troops and Ammunition requir'd in a Fortification to make a good Defence	145
Preparations before a Town is invested	154
Defence from the investiture, to the Attac of the Covert-way	159
Sallies	165
Line of the Counter-approach	171
Retrenchments and their Figure	194
{ Counterscarp	173
{ Passage over the Ditch before the	181
{ Ravelin	187
{ Bastion	189
{ Bastion	196
{ Horn, or Crown Work	198
{ 2d Ditch and a 2d Covert-way	199
Defence of the	199
{ Lunettes, Tenaillons and Counter-Guards	201
{ Faufs Brays	202
{ Place Fortified with Tower Bastions	203
{ Accessible on one side only	204
{ Place on a high Hill	206
{ — situated near a River	207
{ Small Places	211
Precautions a Governor should Use in Time of War	214
Of Capitulations	214

## PART III. of MINES.

Of Mines	224
Definitions of the several Mines	228
Making of Galleries and Chambers	230
Manner of loading and stopping the Mines	233
Powder necessary to charge Mines with, to produce the desir'd effect	235
To charge Mines according to	252
{ M. de Valliere	254
{ The Author's new Theory	258
The Manner of directing the Galleries	260
Of the different Sorts of Mines	242
A Table of the cube Boxes to hold the Charge of Mines	242



Prin-

---

*Principal Terms used in this Book Explained.*

**T**O *Besiege a Place*, is to surround it with an Army, and approach it by passages made in the ground, so as to be covered against the fire of the place.

When an Army can approach so near as the covert-way, without breaking ground, under favour of some hollow roads, rising grounds, or cavities, and there begin the work, it is called, *Accelerating the Siege*.

And when the Army can approach the town so near as to take it, without making any considerable works, the Siege is called an *Attack*.

*To Block up a Place*, is to surround it with a sufficient number of troops, so as to prevent any succour or provision being thrown into it.

*The intent of a Blockade* is, to reduce a garrison by *famine*.

A place should never be blockaded, but on a certainty that there is but a small quantity of provision in it, otherwise it would require too much time, and, perhaps, not be taken at last.

*To invest a Place*, is to surround it with troops, as in a blockade, so as to prevent any succours, &c. It is properly a *preparative for a Siege*.

*To Insult a Work*, is a sudden unsuspected attack, with small arms, or sword in hand.

*Surprise*, is to take a Place by stratagem or treason.

*To Escalade a place*, is to approach it secretly, and to place ladders against the wall, or rampart, for the troops to mount and get into it that way.

*To Petard a place*, is privately to approach the gate, and fix a petard to it, so as to break it open for the troops to enter.

*Line of Circumvallation*, is a kind of Fortification, consisting of a *parapet*, or breastwork, and a ditch before it, to cover the Besiegers against any attempt of the enemy in the field.

*Line of Countervallation*, is a breastwork with a ditch before it, as the line of circumvallation, to cover the Besiegers against any sally from the garrison.

The Works made to cover an Army, so as to command a part of the country, with a breastwork and a ditch before it, are also called *Lines*.

A Work made round the camp of an Army, to cover it against any surprize, is called a *Retrenchment*.

*An Epaulement*, is a breastwork of eight or ten feet high, to cover the cavalry. The breastwork of a battery is also called an *Epaulement*.

*Trenches*, is a general term for all the works sunk in the ground, and made during a Siege, or in any Attack.

*Approaches*, are those trenches which are carried on towards the place in *Zig-zags*, or turnings, so as not to be *enfiladed* by any works of the place.

*Parallels*, or *places of Arms*, are those trenches which join both Attacks, and are, as it were, parallel to the front works of the place.

There are generally three in an Attack of a place.

*Saps*, are trenches made and carried on under cover with gabions and fascines on the flank, and mantlets, or stuffed gabions, in the front.

They



They differ therefore from the other Approaches, in being carried on under cover, and in not being so wide.

*The Rear of an Attack*, is where it begins; and the *Front* or *Head*, that part next to the place. *Breach*, is the opening made in the rampart of a work, either by cannon or mines.

*Assault*, is a vigorous and sudden Attack, made in the breach, to get master of the work.

*Lodgement*, is a kind of trench or retrenchment made in a work, after the enemy is drove out, to cover the troops from the fire of the place.

PLATE I. There are many different kinds of materials used on these occasions, as *Fascines*, *Pickets*, *Gabions*, *Sand-bags*, and *Woolpacks*.

*Fascines*, are composed of branches like fagots, of six feet long, and eight inches in diameter, tied in two places.

There is another size of fascines, three feet long only, called *Sap fagots*.

And when a Fascine is made from twelve to sixteen feet long, it is then called *Saucisson*, and is used in making of batteries.

*Pickets*, are stakes of three feet long, and about an inch and a half diameter, pointed at one end.

*Gabion*, is a kind of a basket without a bottom, every where equally wide, three feet high, and as much in diameter, having nine or ten stakes of about an inch and a half diameter; which exceed the basket-work five or six inches, and are pointed, and generally made by the miners and sappers, who understand this kind of work.

*Sand-Bags*, are sacks of two feet high, and ten inches diameter, filled with earth, and tied very fast.



4 *Explanation of the principal Terms.*

*Wool-packs*, are five feet high, and about fifteen inches diameter, filled with wool; they serve to cover the troops, as soon as they have got possession of a work, till the lodgment is made. Besides these materials, there are *Blinds*, *Chandeliers*, *Mantlets*, *Stuffed gabions*, *Chevaux de frize*, and *Crows-feet*.

*A Blind*, is a wooden frame of four pieces, round or flat, two of which are six feet long, and pointed at the ends, and the others three or four feet, which serve as spars to fasten the two first together.

Their use is, to fix them upright in the ground, against the sides of the saps, to sustain the earth, and to fasten fascines on the upper part, or to cover the sap, and to lay fascines over them, to secure the troops from stones and grenades.

*Chandeliers*, are wooden frames, made of two pieces fixed cross-ways on two other pieces, at about four feet asunder, and upon their intersections are erected two vertical pieces of five feet high, each supported by three buttresses; the interval of these two pieces is filled up with fascines, to cover the troops upon occasion.

*Mantlet*, is a wooden fence, rolling upon wheels, of two feet diameter; the body of the axel-tree is about four or five inches square, and four or five feet long, to which is fixed a pole of eight or ten feet long, by two spars; upon the axel-tree is fixed a wooden parapet three feet high, made of three inch planks, and four feet long, joined with dowel-pins and two cross-bars; this parapet leans somewhat towards the Pole, and is supported by a brace



brace, one end of which is fixed to the pole, and the other to the upper part of the parapet. The use of the mantlet is, to cover the sappers in front against musket-shot.

*A stuffed Gabion*, is a gabion of five or six feet long, and as wide, stuffed quite full with all kind of small wood, or branches; they are used instead of mantlets, and for the same purpose.

*Chevaux de Frize*, is a piece of timber, either round or cut into several faces, through which are drove staves of about an inch and a quarter in diameter, and six feet long, pointed at the ends, so that lying any way, it always presents some points.

Their use is, to prevent the horse from breaking in upon the foot.

*Crows-feet*, is a kind of iron with four points, so disposed as always to have three points downwards and one upwards; they serve also to stop the horse.

The figures of all these materials and machines are represented in the first plate; which, together with what has been said, may be sufficient to have them understood.

The principal terms being explained, the others, which are used hereafter, will also be defined in their proper places.

*Lately published, by Mr. MULLER, Price 7 s. 6d.*

I. **A TREATISE of ARTILLERY :**  
Containing, 1. General Constructions for  
Brass and Iron Guns, for Land and Sea ; with their  
Carriages, Mortars, and Howitzes ; their Beds and  
Carriages, and Dimensions of all other Kind of  
Carriages ; Exercise of the Royal Regiment of  
ARTILLERY, and its Service at Home and Abroad ;  
in a SIEGE or BATTLE ; MARCH, INCAMPMENT,  
AMMUNITION, STORES and HORSES, LABORA-  
TORY-WORK, THEORY of POWDER applied to  
FIRE-ARMS.

II. A SYSTEM of MATHEMATICKS, FORTIFI-  
CATION, and ARTILLERY. In Six Volumes. Il-  
lustrated with One Hundred and Forty large fine  
Copper-plates. Price 1 l. 16 s.

VOL. I. Algebra, Geometry, and Conic-Section-  
s. II. Trigonometry, Surveying, Levelling, Men-  
suration, Laws of Motion, Mechanics, Projectiles,  
Gunnery, &c. Hydrostatics, Hydraulics, Pneuma-  
tics, and Theory of Pumps. Twenty-four Cuts.  
III. Fortification, Regular and Irregular 33. IV.  
Practical Fortification in four Parts 26. V. Artil-  
lery in six Parts 29. VI. Attack and Defence of  
Fortified Places, Mines, &c. Three Parts, 28 Cuts.

III. A SYSTEM of CAMP-DISCIPLINE ;  
Military and Naval Honours, Garrison Duty, Re-  
gulations for Land and Sea Officers, *Kane's Cam-*  
*paigns of K. William* and the *D. of Marlborough*,  
continued to 1757. By an Impartial Hand.

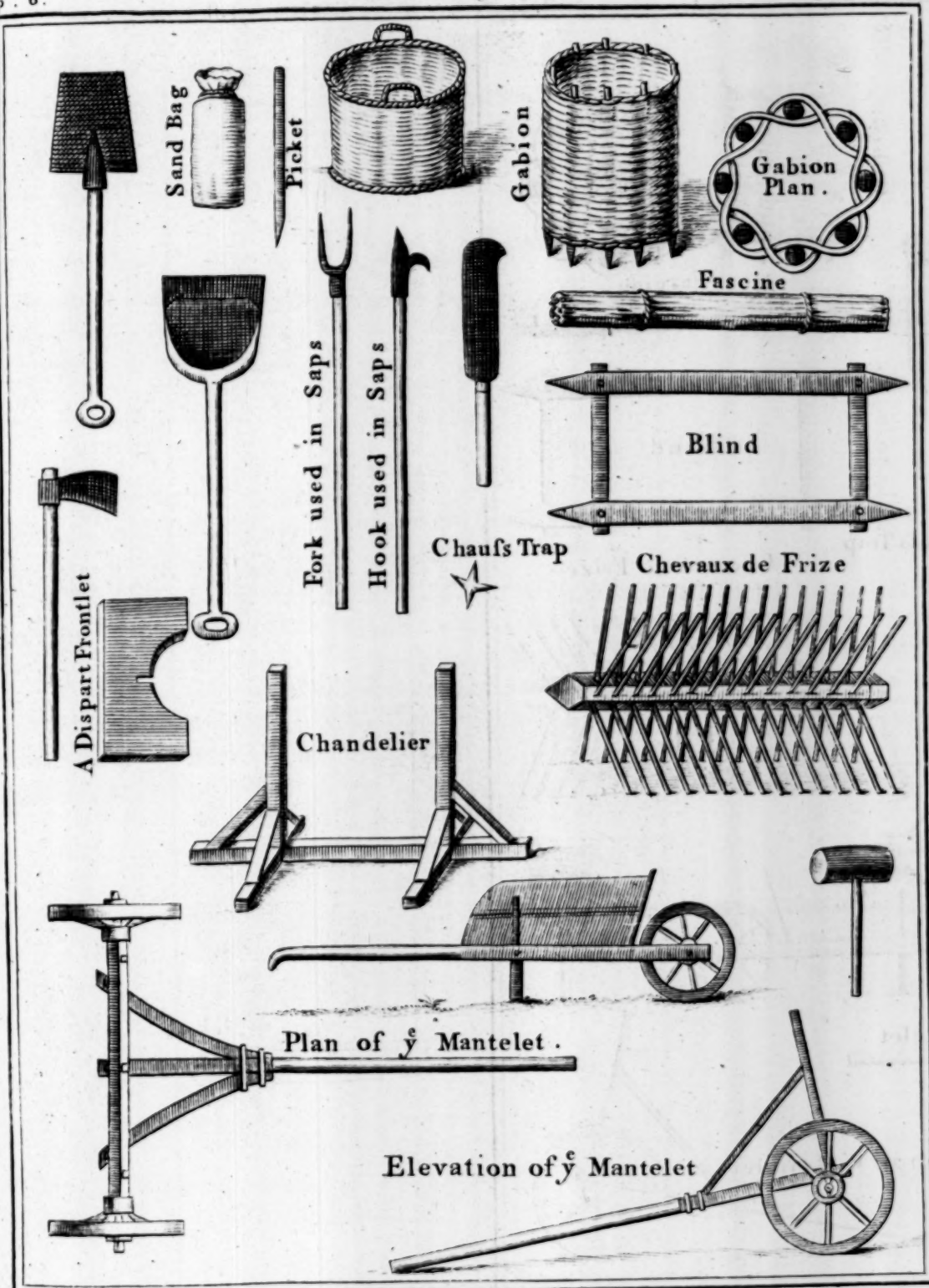
IV. LIST of the ARMY, with a Succession, 3s. 6d.

V. *Millan's* Universal Register of Court and City  
Offices, Army and Navy, &c. 2s. 6d.

VI. *Millan's* Signals, Flags, Coins, Weights, &c. 9s.



A T T A C



---

# ATTAC and DEFENCE OF FORTIFIED PLACES.

---



---

## PART I.

---

**I**N Sieges, as in all undertakings, it is necessary timely to consider every minute circumstance that may happen during the execution of the design, and to provide in the best manner against every seeming obstacle. Not only the General's character, the reputation of his Army, and the glory of his country, are concerned, but a prodigious expence must unavoidably attend such an enterprize; all which are entirely lost in case of a miscarriage, besides the lives of a number of men, a more sensible loss to the nation.

For these reasons, a General, before' he resolves on a Siege, should exactly know, 1st, the strength of the enemy, as well in the field as in the adjacent garrisons; and, 2, what number the enemy may draw from other quarters during the Siege; 3, the strength of the place, its situation, and nature of the ground about it; 4, the strength of the garrison, and goodness of the troops therein, together with the quantity of artillery, ammunition, stores and provision in the place; 5, if the works are countermined or not, and whether any part of



the country about the place may be laid under water, by means of dykes or sluices ; lastly, he should be acquainted with the skill and bravery of the governor, engineers, and the rest of the officers.

These particulars known, he should consider whether he is master of the field, and able to repulse the enemy, if he was attacked during the siege, without leaving the trenches unprovided, and to resist, at the same time, any sally the garrison should make ; and whether, in case the enemy should attack one of his towns during the siege, he may have time to relieve it after the siege is over, or how to provide otherwise against such an accident.

He should also know whether he has a sufficient number of engineers, and their capacities ; whether he has or can provide a sufficient quantity of artillery, ammunition, stores and provision, with the number of horses for draught or carriage ; whether the commandant of the artillery be well qualified for his place, what funds will be wanting, and how they may be supplied ; in fine, he ought to be apprised of every thing necessary for such an important undertaking.

As the success will redound chiefly to the honour of the General, as well as the miscarriage be laid to his charge, he ought therefore to be thoroughly acquainted with these particulars, without being obliged to trust to the judgment or capacity of others.

### STORES.

**T**HE quantity of stores required for a Siege cannot be precisely determined, on account of the various considerations on which it depends ; such



such as the strength of the place and garrison, the capacity of the governor and engineers, the quantity of artillery, ammunition, stores and provision; lastly, on the season, place, situation, &c. But as it is necessary to give some idea to the unexperienced officer, I shall here set down the quantity of each kind, for a month's Siege, as estimated by Marshal *Vauban*, whom we chuse to follow, on account of his great experience and undoubted judgment.

*Stores required for a Month's Siege.*

<b>P</b> OWDER, as the garri- son is more or less strong,		} 8 or 900,000 lb.	
Shot	{ for battering pieces	—	6,000
	{ of a lesser fort,	— —	20,000
Battering cannons,	— — —		80
Cannons of a lesser fort,	— —		40
Small field-pieces for defending the lines,			20
Mortars for throwing	{ shells,	— —	24
	{ stones,	— —	24
Shells for mortars,	— —	15 or 16,000	
Hand granades,	— —	40,000	
Leaden bullets,	— —	180,000 lb.	
Matches,	— —	10,000 braces	
Flints for muskets, best sort,	—	100,000	
Platforms compleat for guns,	—	100	
Platforms for mortars,	— —	60	
Spare	{ carriages for guns,	— —	60
	{ mortar-beds,	— —	30
	{ sponges, rammers and ladles,		20 sets
Tools to work in trenches,	—	40,000	

Several hand-jacks, gins, sling-carts, travelling-forges, and other engines proper to raise and carry heavy burdens, as likewise some to carry water to extinguish fire.

Several

Several parcels of spare timber, for bridges, wheelwrights, carpenters, &c.

There are besides several other things necessary, as miners tools, mantlets, stuffed gabions, fascines, pickets and gabions, in great quantities; tools for smiths, carpenters and wheelwrights; a number of horses for the artillery; carts and waggons, such as can be procured in the country, are also used upon occasion.

### INVESTING PLACES.

**P**Re-requisite to invest a place with success, the General should use various stratagems to deceive the enemy, and prevent their guessing his real design; sometimes the deceit may be carried so far as to invest another place; at other times marching with the army, as if intended to attack the enemy, in order to drive them at some distance from the place, and then return quickly to invest it. In short, no opportunity should be neglected to arrive before the place, before the enemy has either time to throw in troops, ammunition, or provision, since the success of the Siege depends chiefly on this diligence.

The place is invested in the following manner.

A Body of 4 or 5000 horse is detached from the army, if the country is open, or a body of horse and foot, full of defiles or woods, commanded by a Lieutenant-General, and two or three Major-Generals, who march with all possible speed, day and night, till they come within four or five miles of the place, where they halt, to consult, and divide themselves into as many parties as there are principal avenues leading to it; then they march on, so  
as

as to arrive in the dusk of the evening at their several appointed posts, much about the same time; which should be just out of the reach of cannon-shot from the place.

This done, small parties are sent to the very gates to carry off men, cattle, and whatever may be serviceable to the garrison. These parties are to be supported by some squadrons of horse; and it would not be amiss, if they received some cannon-shot, to discover the reach of their guns. In the mean time, the rest of the detachments take their posts in the most convenient places, so as to prevent succours being thrown into the town.

In the day-time they keep without cannon-shot; but as soon as it is dark, the several parties approach the place as near as possible, so as to leave but small intervals between them; then turning their backs upon the town, and placing guards before and behind them, to prevent any surprize, half the troops are to keep always mounted, whilst the rest refresh.

At Dawn they retire by degrees, observing the situation of the place, the nature of the works, and the ground round it, till they come to the former posts, where they place proper guards towards the town, and in all the principal avenues towards the country; the rest repose, keeping their horses saddled for mounting on a minute's warning.

Parties are sent to reconnoitre the enemy, while the commanding officer and engineers pitch upon a proper place for encamping the army, as soon as it arrives, and observe where the line of circumvallation is to be made.

The day the place is invested, the artillery begins to march, with all the stores and ammunition necessary



necessary for a Siege, whilst, on the other hand, the army makes forced marches, and arrives commonly within three or four days after the investing.

The commander of the detachment goes about two or three miles to meet the General, with an account of his proceedings, on which the General settles the disposition of the camp.

The next day he rectifies what mistakes may have happened, and goes to reconnoitre the place, attended by the rest of the general officers, and chief engineers, so that the situation of the line of circumvallation may be determined.

This done, the encampment regulated, and the troops placed in the order agreed on, the General assigns to the other general officers their quarters; the chief or head quarter is fixed upon, as also those for provision, and the park of artillery. All these particulars are to be rectified, so soon as the place for opening the trenches is determined.

In the mean time, small guards are posted near the town, in the most convenient places, sustained by larger, to streighten the garrison as much as possible, and the engineers roughly trace the line of circumvallation, with rods and pickets only, in order to regulate the encampment.

*Disposition and Manner of making the Line of Circumvallation.*

PLATE II. **I**N the tracing this line, regard must be had to the following particulars. 1st, to occupy the most convenient spot of ground about the place, though it be somewhat nearer or farther from the town, than it should otherwise be. 2d, to preserve such a distance, that the camp may be

be without the reach of cannot-shot from the covert-way, which is reckoned to be about 1200 fathoms. 3d, Not to keep a greater distance than is necessary for the security of the camp. The depth of the camp is generally 30 fathoms, and the distance between the front of the camp and the line 120. 4th, To avoid all high places which might command any part of the camp, and when that cannot be done, to take them within the line; but if the line should thereby become too extensive, they must be fortified with redoubts, or other out-works.

All advantages arising from the nature of the ground are likewise to be made use of; such as precipices, morasses, rivers, brooks, hedges, and, where it can be done, felling of trees.

The dimensions of the several parts of the line of circumvallation are, 1. The distance from the point of one *Redan* to that of the next, is commonly 120 fathoms; sometimes 10 or 12 fathoms, more or less, according as the nature of the ground will permit. 2. The openings or gorges of the *Redans* about 30, and their capital or depth 20: The *Redans* are to be placed on the higher part of the ground. As to the rest, the form and situation of the line is always adapted to the nature of the ground, and, provided it is every where well flanked, it will be sufficient.

The gorgers of the *Ravelins*, which cover the gates or sally-ports, are thirty fathoms, the capitals twenty, and the flanks six: The ditch before the line is from fifteen to eighteen feet wide above, but reduced to one-third below. Hence a ditch of eighteen feet wide above, will be but six feet at the bottom; and if its depth is seven feet and a half

half, the excavation of fix feet, or one fathom in length, will be fifteen feet, or two cubic fathoms and a half, which is reckoned to be as much work as one man may conveniently do in seven days.

According to this computation, I shall insert the measures of fix different profiles given by M. *Vauban*, which may serve on all occasions.

Prof.	PARAPET.				DITCH.			
	Thickn.	Heighth within.	Heighth without.	width above.	Width below.	Depth	Solid Cont.	Days Work
I	8 : 0	7 : 6	6 : 0	18 : 0	6 : 0	7 : 6	15 : 0	7 Days
II	7 : 0	7 : 6	6 : 0	16 : 0	5 : 4	7 : 0	12 : 5	6 : 18
III	6 : 0	7 : 6	6 : 0	14 : 0	4 : 8	6 : 6	10 : 1	5 : 16
IV	6 : 0	7 : 6	6 : 0	12 : 0	4 : 0	6 : 0	8 : 0	4 : 0
V	5 : 0	7 : 6	6 : 0	10 : 0	3 : 4	5 : 6	6 : 1	3 : 0
VI	4 : 0	7 : 6	6 : 0	8 : 0	2 : 8	5 : 0	4 : 5	2 : 0

N. B. All the dimensions are expressed in feet and inches, as well as the solid contents, fix feet of which make a cubic fathom, 12 inches a foot, supposing the length of the excavation to be fix feet, as mentioned above \*.

Supposing a cannon-shot from the covert-way to reach 1200 fathoms, allowing 200 more to the rear of the camp, makes 1400 ; then taking 30 for the depth of the camp, and 120 more for the distance from the front of the camp to the line, the whole includes

\* The method of computing the solid content is, to multiply half the sum of the width above and below of the ditch, by its depth, and divide the product by six. See my *Elem. Mathem.* p. 247.

includes a distance of 1550 fathoms between the line and covert-way.

Now if the Place to be attacked is a regular *Octagon*, fortified according to M. *Vauban's* first Method, the distance from the center of the place to the covert-way, will be about 250 fathoms, which being added to 1550, gives 1800 fathoms for the distance of the line from the center of the place ; and the circumference of the *Radius* 1800 will be 11314.

Therefore the line of circumvallation would be 11314 fathoms, if it was circular ; but on account of its turnings and redans, there may be added 1880, making together 13194 fathoms, which being divided by 2282 (the number of fathoms or toises contained in a *French* league) gives about  $5\frac{1}{2}$  leagues or 17 *English* miles, for the whole extent of the line.

The parts of the line most exposed to be insulted, are palissaded, and sometimes out-works are added, or a second ditch ; and when any particular part is more in danger than the rest, holes or pits are made chequerwise of 5 or 6 feet deep, and about 8 feet wide above, with stakes planted in the middle of them, projecting about a foot above the surface of the ground, to prevent the cavalry from breaking in that way.

In general, the Line should be every where equally strong ; and therefore, if some parts are strong by nature, the rest ought to be made so by art.

As the tracing the Line on the ground admits no manner of difficulty, there is no occasion to say any thing of it.

As fast as the Line is traced out, the ground is distributed amongst the troops and peasants, if any  
are



are to be had; this is done equally both to horse and foot, no body being excused from this kind of duty.

The Sub-engineers divide the work between them; they are to take care that the work is well performed, and the dimensions rightly followed; and the General Officers observe that the Engineers before their own quarters perform their duty: In the mean time, the chief and sub-directors are employed in reconnoitering the works of the Fortification, and the ground about it; of which they are to give an account to the General, that he may fix upon the place of Attacs. The finishing the Line generally takes up 8 or 10 days.

#### BRIDGES of COMMUNICATION.

AS the camp is generally divided by rivers, brooks, or marshes, it is of great importance to make a sufficient number of bridges or causeways, that the communications between the several parts of the camp may be quite open and free, the neglect of which \* has many times occasioned the raising of the Siege, with the destruction of a great part of the Army.

These bridges ought to be made as firm and secure as possible; there should at least be four of them between each of the several quarters, at about 40 or 50 fathoms distance from one another; their

\* The *French* found by woeful experience the truth of this at the Sieges of *Turin* and *Valencienes*; at the former, tho' they were 72000 strong, Prince *Eugene* attaced them with 24000 men only in one of the Quarters separated by rivers from the others, and where the bridges were neglected, defeated their Army, and raised the Siege; and at the latter, half their Army, commanded by Marshal *La Ferté*, and separated from the other by a river, was entirely routed, and the Siege likewise raised.

their avenues of easy access, and guards placed near them, to see that they are constantly kept in repair. These bridges are always placed within the Line of circumvallation, so that those who pass and repass over them, may be secure, and out of all danger from the enemy.

#### GATES *and* SALLY-PORTS.

**T**HE Gates are made in the principal avenues and great roads, covered with ravelins, and sometimes with small horn-works, when the Line may be easily attacked on that side: and in every second curtain is made a Sally-Port of 24 feet wide, which is shut up by an horizontal beam turning upon a spindle post, which stands in the middle of the gateway.

#### PARK *of* ARTILLERY.

**W**Hilst the Line of circumvallation is making, the commander of the Artillery is employed in making the park, which ought to be placed in the part most remote from the town, and the least exposed to be insulted, but at the same side where the attack is to be made; it is made in the form of a square redout, with a breastwork and a ditch round it, and the entrance is covered with a redan, or small ravelin.

Besides this, which for distinction sake is called the Great Park, and which contains all the Artillery, ammunition and stores of the whole Army; there is also a smaller one, at the rear of each attack, to hold the Artillery and stores which are used daily in the trenches, and which are continually supplied from the great Park. These latter

C

need

need not be so well secured as the great one; provided they are free from cannon-shot, it is sufficient.

I shall hereafter explain at large, how this Park is to be formed, the stores are to be disposed, and the quantity of each fort required.

#### LINE *of* COUNTERVALLATION.

**T**HIS Line is of the same nature, and made in the same manner, as the Line of circumvallation; as the former is intended to secure the Army against any attempt that the enemy may make from the field, so this latter is made to secure it against those from the garrison. For which reason, it is made between the camp and the place, and the redans, together with the ditch, are on that side next to the place. This Line is not made so strong as the former, neither are the redans so near each other; and therefore the 6th profil may be used for it.

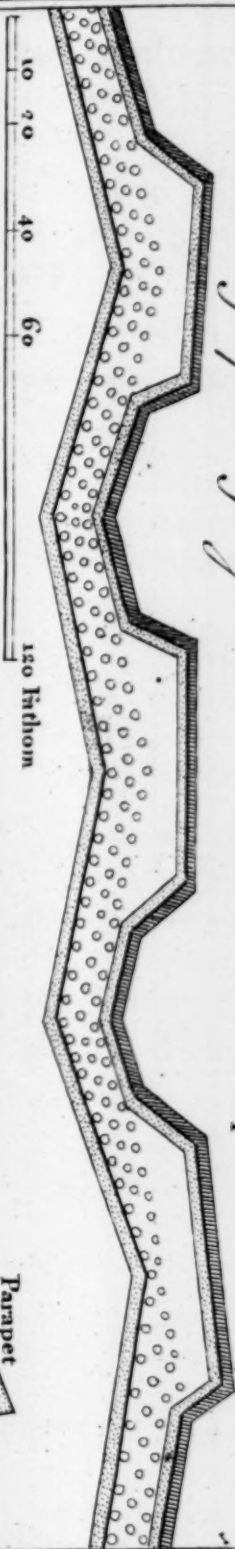
There are few Lines of countervallation made now, because the Besiegers are generally so superior to the Besieged, that they are under little apprehension from them. The Line of circumvallation has even of late been neglected, when the Army of the Besiegers has been \* much superior to any that could come to relieve the place.

#### P R E P A R A T I O N S *for the* A T T A C.

**A**S soon as the Army is arrived, and encamped, fascines, pickets, and gabions are got ready, against the time of opening the Trenches; they are brought

\* The French made no Line of circumvallation in the late Siege of Tournay.

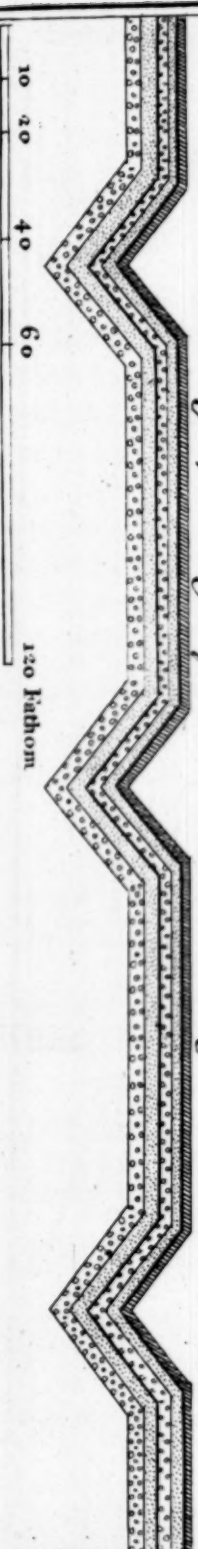
Plan of part of  $y^e$  Circumvallation at Philipsbourg in 1734.



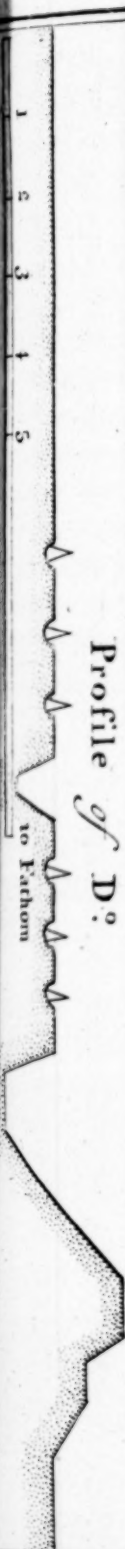
Profile of  $D^o$



Plan of part of  $y^e$  Circumvallation of Arras in 1654.

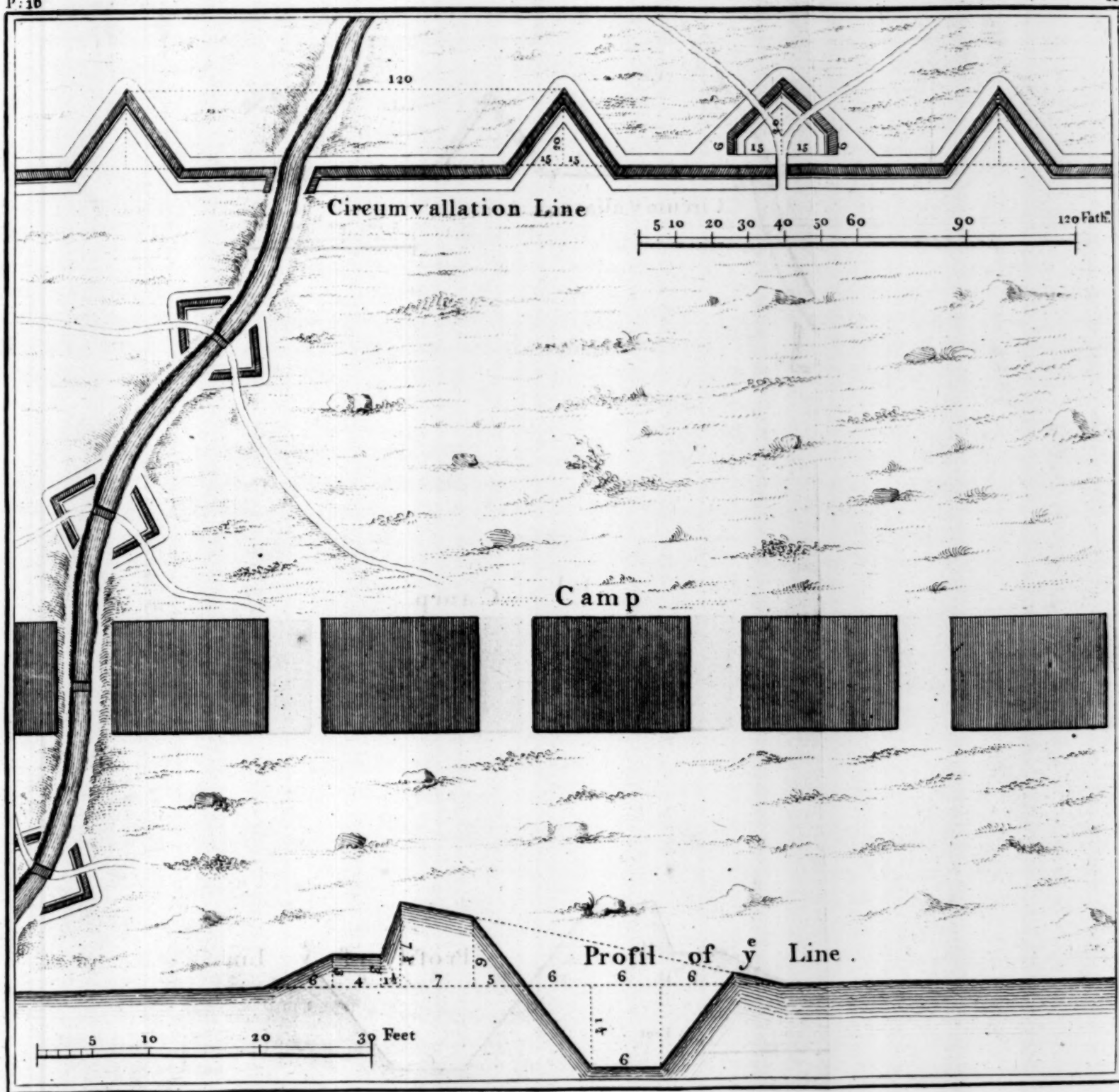


Profile of  $D^o$











brought to the camp by 2 or 3000, a battalion, and 12 or 1500 a squadron, and placed in the fronts of their respective camps.

There are also several other things to be provided, as spades, shovels, pick-axes in great numbers, iron hooks, and forks with long poles fixed to them, for ranging and setting the gabions; mallets, wheel-barrows, hand-baskets and sand-bags in great quantities; as likewise mantlets, stuffed gabions and saucissons.

All these things must be ready and at hand, before the Trenches are opened; also the Guns mounted upon their carriages, the mortars upon their beds; the materials for making the batteries and the platforms must also be in readiness, together with every thing else required in the Attac.

In the mean time, the Director of the Siege continues reconnoitering the different works of the Fortification, as likewise the ground about it, in order to make the plan of the Attacs.

There are a great many things to be observed in the tracing of the Attacs; it requires undoubtedly, the utmost skill and industry of an Engineer to fix on a proper place, and to adapt the works to the nature of the ground, the neglect of which has often been the occasion that places were attacked on the strongest sides; and sometimes the Besiegers were obliged to change the place of their Attacs after much time and labour spent.

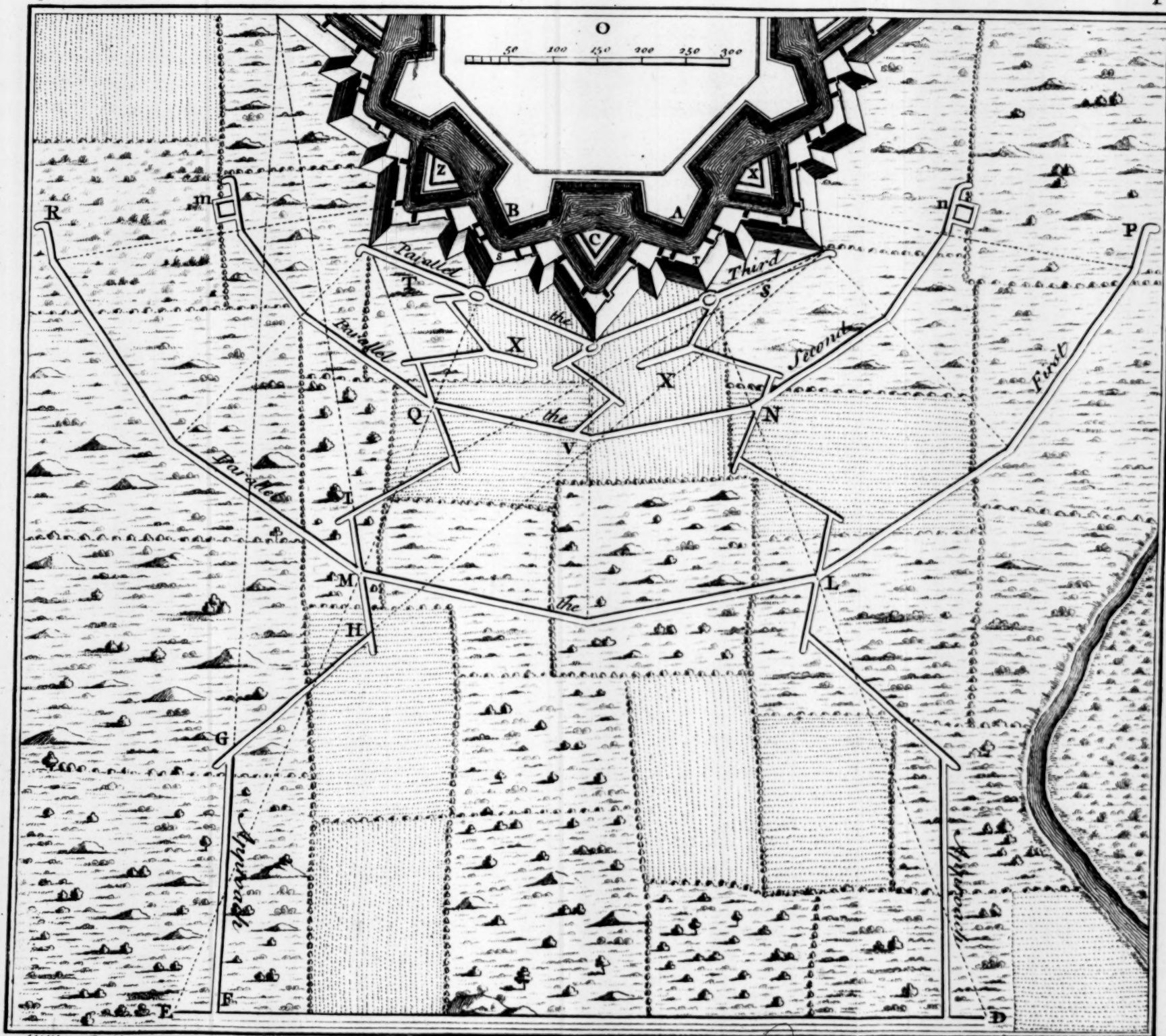
To give the reader a clear idea of the tracing an Attac, we shall suppose here a regular octagon, with all the sides equally fortified, so that it is indifferent which of them is attacked, and endeavour to explain the general rules or maxims whereby they are constructed, in as plain and full a manner

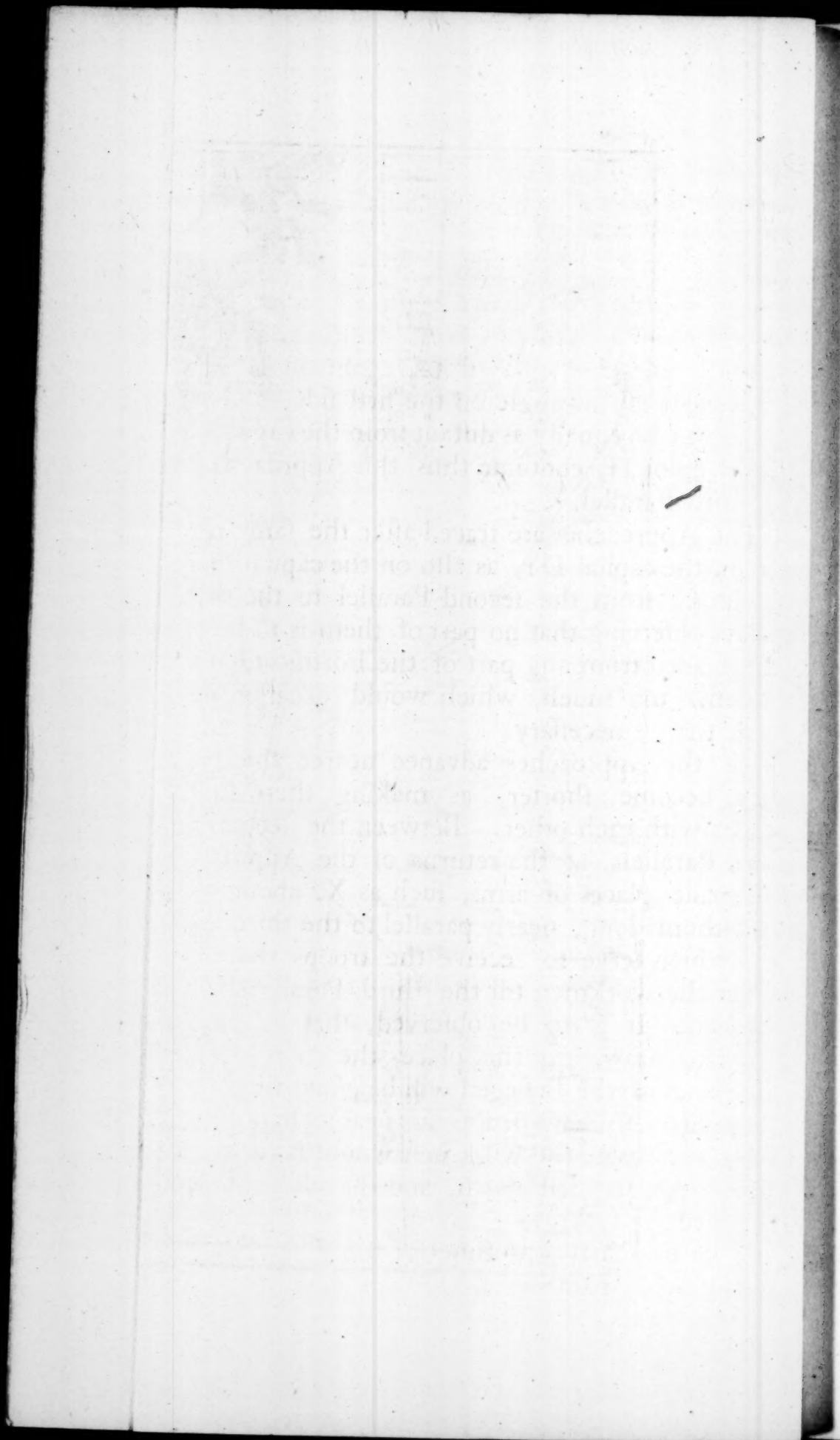


as possible; which being well understood, will leave, I hope, no manner of doubt in the reader's mind, especially when applied hereafter to irregular places.

*To CONSTRUCT the ATTACS on PAPER.*

PL. IV. **L**ET, A, B, be the bastions to be attacked, whose capitals, as well as that of the ravelin C, being indefinitely produced towards the field, set off 300 fathoms from the salient-angles r, s, of the covert-way to the points L, M; and from the center O of the place describe an arc of a circle through the points L, M, whose intersections with the capitals will terminate the several parts of the first Parallel P L M R; which is terminated at 20 fathoms beyond the faces produced of the two adjacent ravelins x, z, next to the front attacked. Take L N, M Q, each equal to 140 fathoms, and describe from the center O another part of a circle through the points N, Q; and its intersections with these capitals, will terminate the several parts of the second Parallel n N Q m, which extends ten fathoms only, beyond the faces of the ravelins x, z. Lastly, draw lines through the salient-angles of the glacis, and they will give the third Parallel S T. This being done, take the points D, E, in the capitals of the bastions, at about 300 fathoms from the salient-angles r, s, of the covert-way, and join them by a right line, which will express the beginnings of the Attacs. From the point F in D E, at about 24 or 26 fathoms from the point E, draw a line F G, of any length, as 120 or 126 fathoms, for the first Approach; but so as when produced to fall 10 or 12 fathoms







fathoms from the farthest saliant-angle of the covert-way ; from the point G draw GH, so as to fall as much from the farthest saliant-angle on the other side of the place ; and the point H is taken so as to be nearly at the same distance from the capital s E, as the point G ; and from the point H draw the line HI, so as to fall again as far from the farthest saliant-angle on the first side, and that the point I be equally as distant from the capital s E, as the point H, continue thus the Approaches to the third Parallel.

The Approaches are traced after the same manner on the capital D r, as also on the capital of the ravelin C, from the second Parallel to the third ; always observing that no part of them is to be seen or enfiladed from any part of the Fortification, nor to defile too much, which would occasion more work than is necessary.

As the Approaches advance nearer the place, they become shorter, as making then smaller angles with each other. Between the second and third Parallels, at the returns of the Approaches, are made places of arms, such as X, about 30 or 40 fathoms long, nearly parallel to the third Parallel, which serve to receive the troops that are to cover the workmen till the third Parallel is quite finished. It is to be observed, that as the Approaches draw near the place, the more frequent the sallies of the Besieged will be ; and therefore it is necessary to have troops as near at hand as possible, otherwise the workmen would take to their heels upon the first alarm, and the work be much retarded.

The principal or outlines of the Trenches being thus traced, parallels are drawn to them, on the



side towards the field, at 12 feet distance in the Approaches, 15 in the first and second Parallels, and at 18 in the third; then the intervals between these and the former lines, will express the width of the Trenches.

At the ends of the second Parallel are made square Redouts, such as m, n, of about 10 or 12 fathoms each side, to protect it more effectually from the sallies of the Besieged.

The first part D E of the Trenches, is an *Epaulement* of about 10 feet high, to cover the horse designed to guard the Trenches; but if there should be some rising ground thereabout, that Epaulement need not be made.

*Note*, the ends of the Approaches next to the field are produced 2 or 3 fathoms, in order to cover the parts which they terminate, and serve for some to retire into, upon occasion, that others may pass and repass, without trouble or confusion.

The Trenches are commonly 3 feet deep, and the height of the parapet 7, from the bottom of the Trenches. As to the rest of the dimensions, they may be seen in the profiles of the 5th PL. V. Plate; where it may be observed, that the breastwork of the third Parallel is made with several steps, so that the troops placed there may pass over it without confusion, when occasion requires.

### O B S E R V A T I O N.

**T**HIS method of tracing the Trenches was invented by M. *Vauban*, and has been in use ever since, as being undoubtedly the best hitherto contrived; yet in my opinion, if the Approaches were carried on in right lines, from the beginning to

to the first Parallel, meeting it nearly in the same point as the capital; that is, if the line I H was produced backwards, till it meets the line D E, the Approaches made in that line would be better than the present ones, as they would be shorter, and require less work, and the passing and repassing attended with less confusion. The tracing them on the ground likewise might be done with greater ease and exactness, as requiring but two pickets to direct them, which might be placed either in day-time, or in the dusk of the evening; and as they are pretty far from the place, the Besieged would find it a hard matter to enfilade them, which is the only objection that can be made against that way of making the Approaches.

It is farther to be observed, that the earth dug out of the Trenches is always thrown on the side next to the place to make a parapet of it; the side where the parapet should be, is expressed by a strong line. See Plate IV.

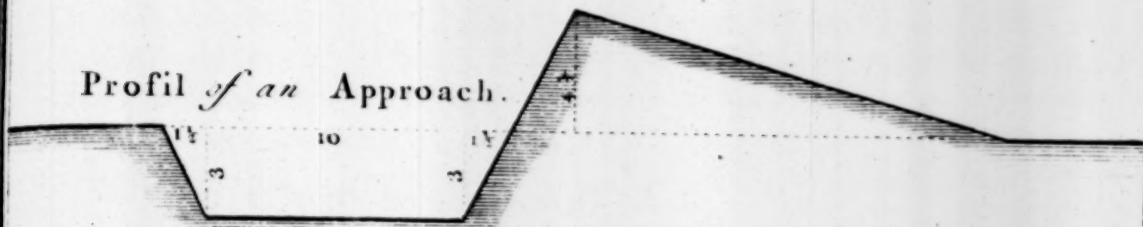
The foregoing method being well understood, there will remain no difficulty in the tracing the Attacks, by having a good Plan of the place, tho' never so irregular, both in respect to the works and the ground about it; but it is not so easy to transfer the works from the Plan to the ground, especially when it is such as all the parts of the Trenches cannot be equally extended. As the great variety of the situations which are to be met with, and which cannot possibly be described, no more than the various manner of executing the Plans can be shewn, I shall explain how it is done in several cases, in order to render it as intelligible to the reader as the nature of the subject will admit of.

The capitals of the several works before the front of the attack, are to be marked on the ground, by observing the directions of their saliant-angles, and the opposite ones of the covert-way ;  
 PL. IV. and a picket being placed therein as near the Town as possible ; then going backwards, so as to place another in the same direction ; these two pickets will serve to place as many more in that direction as are thought necessary. Having the capitals on the ground, the points D, E, where the Approaches begin, must be found exactly, either by trigonometry or otherwise ; then measuring the distance EF on the paper, and setting it off on the ground, the point E, where the approaches begin will be found.

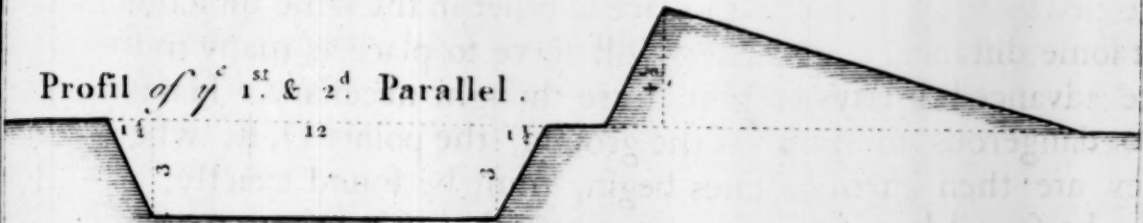
To find the next point G on the ground, draw, in the Plan, a perpendicular from that point to the capital, which being measured, as well as its distance from the point E, and traced upon the ground, will give the point G, from which a line may be traced with a small rope to the point E. The tracing may be thus continued at pleasure. It must be observed, that the perpendicular may be marked on the ground, very nearly by guess only ; or ropes may be tied together, so as to make a right-angled triangle, by which it may be found pretty exact.

The following method is often used for the sake of greater expedition. The Engineers observe the directions of the Approaches some days before the opening of the Trenches, measuring their length by paces, and plant pickets at their returns, in the dusk of the evening ; then the next day they observe whether these pickets are rightly placed, if not, they alter them, and continue so in this manner

*Profil of an Approach.*



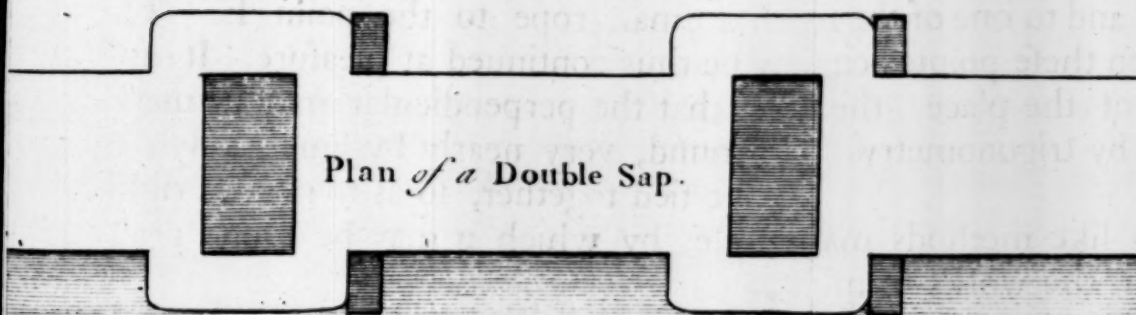
*Profil of  $y^c$  1<sup>st</sup> & 2<sup>d</sup> Parallel.*



*Profil of  $y^c$  3<sup>d</sup> Parallel.*



*Plan of a Double Sap.*



*Plan of a Single Sap.*





ner, till they have marked all the turnings as far as the second Parallel ; and when the Trenches are to be opened, they lay only fascines in those directions observed before ; by this means the works are carried on with ease and exactness.

If the nights are dark, burning matches or bundles of white straw, are tied to the pickets, in order to be discoverable at some distance.

When the works are advanced pretty near the Town, it would be too dangerous to trace them uncovered ; but as they are then carried on by saps, the directions may be found by means of instruments, and they may afterwards be carried on to the lengths expressed in the Plan.

It will be proper to find now and then the distances of the works from the covert-way, so that if any mistake should have happened, they may be rectified. The best instrument for this purpose is Dr. *Hadley's Sextant*, by which the angles made by lines drawn from any place, to the salient-angles of the opposite bastions, and to one of the shoulders, and the distances between these points being known from the construction of the place, the distance required may be found by trigonometry. See my *Elem. Mathem.* p. 206.

These and other such like methods may be observed, in laying down the works from the Plan upon the ground ; the situation of the place and the nature of the ground about it, will suggest many other means to proceed by, which can no ways be expressed, or thought on before hand.

OBSERVATIONS *relating to the properest Place for making the ATTACS.*

**H**AVING a sufficient knowledge of the several parts of the Fortification, by means of spies, deserters, prisoners, and from printed or drawn Plans, the nature of the ground about the place must be well examined and observed, whether there are any hollow ways, or cavins, by means of which the Trenches may be opened nearer than usual; whether the soil be easily dug, or if it be gravel, rock, or sand, marshy, dry, or wet; whether any part of it may be laid under water, by means of dykes or sluices, or the morafs may be drained, or passed over with some trouble.

If a Town be situated near a river, with a Fort on the other side, it will be best to attac that side next to the river, so that one flank of the Attacs being secure from any attempt that way, the troops may be at liberty to act with greater force on the other. Opposite to this Attac, on the other side of the river, near the Fort, must be another Attac made, and Batteries so placed as to destroy the bridge of communication between the Town and the Fort; and when the Fort is taken, batteries are to be raised ne ., or in it, to flank and enfilade the works of the front attacked.

But if the river passes through the Town, and is pretty large; then the Attac should be made upon the front farthest from the river, otherwise the enemy may raise batteries on the other side of the river, to enfilade and annoy the Trenches; and if to prevent this, another Attac is made on the other side, they must be both equally supported, lest,

as they cannot assist one another in case of need, the Besieged should fall upon one of them, with their whole strength, and destroy it.

If there be an Island near the Town, from whence any of the works may be seen or enfiladed, it will be necessary to get possession of it, and erect batteries there. If there happens to be any marshes, which cannot be drained or passed over, it will be proper to flank one side of the Attack with them, for the same reasons as when near a river; but if the marshes are to be crossed by any means whatsoever\*, unperceivable by the Besieged, the doing so will accelerate the Siege pretty much; because places are always least fortified on those sides.

The place and ground about it having been sufficiently examined, the chief Director of the Engineers makes a Plan of the Attacks, and specifies in writing the particular reasons why he chuses to attack the place on that side, which he gives to the General to have his approbation.

The Commander in chief of the Artillery is also to be consulted about the number and disposition of the batteries, as being, or supposed to be the best Judge of what belongs to that branch of the business.

It was formerly the custom to make sham Attacks, only to amuse the Besieged and conceal the real one; but as they are found out in about three or four days, and are an additional expence and labour, they have been neglected of late.

It

\* At the Siege of *Beuchain*, the late General *Armstrong* carried a work through marshes full of reeds, in one night's time, by means of hurdles and fascines; which contributed much to the speedy surrender of that Place.

It is true, that when the place is of great importance, and the Besiegers Army numerous, they generally make more than one Attac, especially when there is a Citadel; then they usually carry on one against it, and another against the Town, as the *French* did in 1745 at *Tournay*.

The Attacs should never be separated, unless the Town is weakly garrisoned, or the Besiegers very numerous. The double ones are much preferable, as they may afford mutual assistance to each other, and fatigue the garrison as much as if they were separated; and no single Attac should ever be made, but when there is not space enough to make two, as it sometimes happens when the place is surrounded with marshes, and there is no way of coming at it, but by causeways. Then, the utmost precaution should be used to support every part of it, in the best manner possible, by making places of arms, from distance to distance, with fascines and gabions, for want of earth, to prevent the Besieged from falling on the workmen and their guard, and destroying the works.

The Plan of the Attacs being settled, the little parks of Artillery, as also the hospitals, are to be placed as near the opening of the Trenches as possible, for the more easy carriage of the Artillery, ammunition, and stores, into the Trenches, and bringing the sick and wounded out of them.

These Parks are to contain a sufficient quantity of artillery, ammunition, powder, and stores, and all kinds of tools for digging the Trenches, as also for sapping; in short, every thing necessary for the daily use of the Trenches; and as fast as they are either expended or spoiled, they must be supplied from the great Park. The little hospitals are  
made



made of tents only, as being supposed out of the reach of cannon-shot from the place; they should be provided with chaplains and surgeons, all kinds of medicines and apparels for the immediate use of the sick and wounded brought from the Trenches.

The place of Parade, where the troops ordered for the Trenches are drawn up, is also to be as near the openings of the Trenches as can be, that they may not have a great way to march; for the same reason the General's quarters should be likewise near at hand, as has been observed, to see and order every thing required for the daily service.

The roads from the several quarters, to the rear of the Attacks, should be made on the driest ground, out of the reach of cannon-shot; care must be taken to keep them in constant repair, so as to be at all times an easy safe passage.

If a spring or brook should happen to be near the rear of the Attacks, care should be taken that the water be kept clear, and no dirt or nastiness thrown in, being one of the most useful things for the support of mankind; for which reason a Guard should be placed over it, and if the guns of the Besieged should be able to interrupt the access, or make it dangerous, a trench must be made to it.

The Engineers quarter, as likewise that of the miners and sappers, should also be near at hand, as being the most necessary people in carrying on the Trenches; and therefore the nearer they are, the better.

The Attacks being resolved upon, the guard for the Trenches should be regulated in such a manner, as to be at least equal in foot to three fourths of the Garrison, and to exceed it by one third more in horse; so that if the Garrison consists of four  
thou-

thousand foot and four hundred horse, the Guard is to be three thousand foot and six hundred horse.

It was formerly computed, that the Army of the Besiegers should be ten times the strength of the Garrison, but this rule can only be true in some particular cases; for when the Garrison is either very small or very large, the Army would be too small or too great. For example, if the Garrison consists of a thousand men, then, according to this rule, the Besiegers should be ten thousand, which are too few, since the least Town requires a Line of circumvallation of ten miles; so there would be but one thousand men to guard a mile of the Line, and furnish troops besides for the Guard and works of the Trenches; which would not be sufficient to prevent the enemy's throwing succours into the place; on the other hand, if the Garrison were sixteen thousand men strong, as that of *Lisle* was, when besieged in Queen *Anne's* War; the Besiegers should then be one hundred and sixty thousand, which are a great many more than are necessary.

In my opinion, there can be given no general rule, whereby the number of troops required for a Siege of all sorts of places, may be determined, as depending on too many different considerations, without the exact knowledge of which there can be no such thing as making a true estimate. At present, Sieges are carried on with such numerous Armies, and so great quantities of Artillery, as that it is hardly possible for a Garrison to make a long resistance; and it is beyond dispute, that the greater the Army is in comparison to the Garrison, the sooner the place will be obliged to surrender.

The number of Engineers necessary to carry on the Siege, should be thirty at least for a middling place,

place, and from forty to fifty for a strong one. As they are absolutely necessary in a Siege, there cannot be too many of them, and being more exposed than any others, there are always many of them killed and disabled. They are divided into Brigades of six men each; *viz.* a Director, a Subdirector, and four Engineers.

As to the number of Artillery men, there should be in my opinion, no less than a battalion of eight hundred including the miners and sappers. The *French* have never less than two compleat battalions.

*Of Opening the TRENCHES.*

**W**HEN every thing is ready, the Line of circumvallation being nearly finished, and a great quantity of fascines and pickets at the front of the camp, and all kind of necessary tools in the little parks, as likewise the Artillery in readiness, the day for opening the Trenches is resolved upon. The General settles the Tour of duty for the guard of the Trenches both of horse and foot, so as to have five or six days rest; also the number of horse for bringing the fascines and pickets from the front of the camp, to the place of opening the Trenches, and the number of pioneers for each day, and each night: All which is done a day or two before the Trenches are opened.

The Major-Generals of the horse and foot consult with the chief Director about the number of men necessary for each day's service, and take care to have them in readiness whenever they are called upon.

The chief Director settles also, with the rest of the Engineers, the particulars of their business, and  
gives

gives them copies of the Plan of the Attacs, with written instructions, so that they may the better follow his orders; and they take care to be provided in time with pickets, mallets, rods, and ropes for tracing the Trenches.

A small guard is placed at the rear of the Attac, to take care of the tools and instruments lodged there, and not to suffer the place to be too much frequented, it being prudent to conceal the design from the enemy, as long as possible.

The day for opening the Trenches being come, the guards parade about two or three in the afternoon, and prayers are said; then they file off before the General, if he thinks proper. The pioneers meet likewise hard by, having each a fascine, picket, spade, and a pick-ax.

In the dusk of the evening the troops advance; the grenadiers, and other detached bodies, who are to protect the workmen the first night leading the van, followed by the battalions designed for the guard of the Trenches, and the pioneers in the rear; these last are, according to M. *Vauban*, divided into brigades of fifty men, each commanded by a captain, a lieutenant, and two serjeants, and march four or six in front. Each soldier of the guard carries a fascine besides his arms every time they mount during the whole Siege.

When the front of the troops is arrived at the place where the Trenches are to be opened, the Director of the day leads the brigades of the pioneers forward, and places them where the Trenches are to be made, whilst the guards of foot place their fascines at the opening, retire behind some cover, if there is any, or where the Major orders them, and lie down upon their arms,  
ready



ready for service whenever they are called upon. The guard of horse march likewise to their assigned posts, at the right and left of the opening, ready to support the foot, in case of any sally from the enemy.

In the mean time, the Director places the first rope, and shews to the rest of the Engineers what is to be done, that they may continue the work; then he makes the pioneers file off one by one, each carrying his fascine under the right arm, if the Town is on the right, or under the left, if it is on the left, and begins himself to place the first pioneer, then the second, third, fourth, &c. successively one after another, ordering silence, all to lie down, and not begin to work till commanded.

When the Director has placed several pioneers, he leaves the first Engineer to place the rest, whilst he goes to see how the tracing is carried on; he takes care that the branches of the approaches next to the field, are produced two or three fathoms, as was said before, to cover those which they terminate, from being enfiladed; that the fascines are laid on the side next the Town, and that the Approaches, when produced, fall neither too far off nor too near the farthest salient angles of the covert-way, but within about ten or twelve fathoms of them.

It is supposed that the chief Director has taken such measures as to carry the Trenches so far as the first Parallel, the first night, and that even a part, if not all, of that Parallel, be made.

Whatever has been said with regard to one Attack, ought likewise to be understood with regard to the other; and it is to be observed, that they

D

should

should both advance together equally; and if one should meet with any obstacle, the other must wait for it; to prevent the enemy from taking any advantage of that which is most advanced.

When every thing is ready, the word or signal is given to begin the work, taking care that the earth is thrown on the side directed, and all possible diligence is to be used till day appears; then part of the detachments retire behind the Parallel began, and the rest behind the head of the Approaches, and lie down on their faces, the works being as yet imperfect.

The workmen of the night are relieved in the morning by an equal number who begin to work at the head, contrary to those of the night, who began at the rear; these are to finish, if possible, what the others have begun; but if that cannot be done, a detachment of 100 or 200 men are ordered extraordinary the second day to finish it.

As the design is known to the enemy, the guard mounts the next day, with drum beating about four in the afternoon, in order that the commander may have time to visit the works, and know what is to be done next night, in which the workmen advance uncovered in the same manner as the first, and they continue so to the second Parallel, always finishing by day what was begun by night; and as soon as the works are in a condition to receive the troops, they retire into them, with order to those at the head of the Approaches, together with the workmen, to retire also, in case the enemy should make any fall; as not being yet in a condition to repulse them.

The second day as many workmen as are necessary are ordered to finish what was left to be done, especially

especially the first Parallel, being the constant receptacle of the guards for the Trenches, till the second is quite finished.

The work is thus continued day and night with all possible speed, advancing as far by night as possible, and finishing by day what was begun by night; and if the same number of workmen is not sufficient, more are ordered for that purpose, that nothing may be wanting to carry the works with all expedition as far as the second Parallel.

When the works are advanced to the second Parallel, the fire of the enemy becomes too dangerous to proceed farther uncovered; and therefore it will be proper to carry on the works by saps; tho' in the night, when their fire begins to slacken, some part may be still carried on uncovered; but this should be done with great caution; for it is an inviolable maxim never to expose men without an absolute necessity, which however is too frequently done by forward Commanders, who think little of sacrificing many brave men's lives to their own hasty Ambition.

Before we proceed farther with regard to the Trenches, it will be necessary to shew how the batteries are placed before the first Parallel, reserving to treat of the others in due order.

*BATTERIES placed before the first PARALLEL.*

**T**HE first Batteries are no where so conveniently placed as about fifty toises before the first Parallel, and if the ground is any ways advantageous, they may continue there during the whole Siege.

The Intent of the batteries will naturally point out their situation; they serve for two purposes, *viz.* to dismount the Besieged's guns, and drive the enemy from their defences, by enfilading the faces of those works which command the front of the Attac.

A Battery intended to dismount the guns of the Besieged, should be directly or nearly opposite to them; and in order to enfilade any work, it ought to be perpendicular to that work.

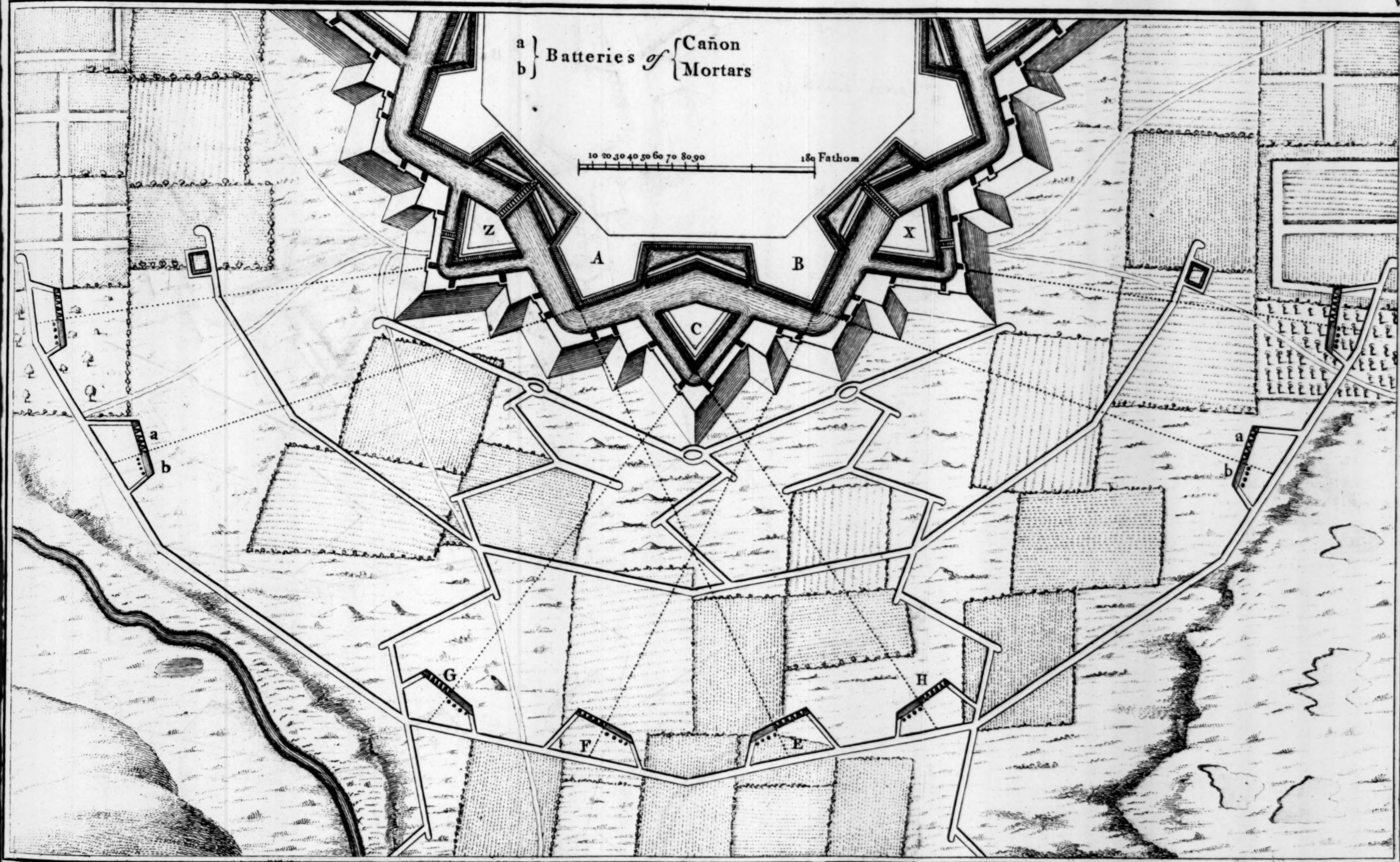
Hence the Battery E, which is perpendicular to one of the produced faces of the bastion  
 PLATE VI. A, is also nearly parallel to the other face, and may therefore either enfilade the face to which it is perpendicular, when fired *à Ricochet*, or dismount the guns placed upon the other face to which it is nearly parallel. It may be observed, that it is not absolutely necessary that the Battery should be directly opposite to the face, in order to dismount the guns placed on it; for by being a little oblique, there is a better chance for a shot's hitting one gun if it misses another.

The Battery F, which is perpendicular to one of the faces of the bastion B, will enfilade it by firing *à Ricochet*, and dismount the guns placed on the other face, when fired in the usual manner. Likewise the Batteries G, H, which are both perpendicular to one of the faces of the ravelin C, will enfilade that face to which they are perpendicular, and dismount the guns placed on the other.

From whence it appears, that as many Batteries are required in an Attac, as there are faces of the works which flank the Trenches: and therefore there are eight Batteries required in such an Attac as this, *viz.* two for each of the bastions A, B;

two





two for the ravelin C; and one for each of the adjacent ravelins x, z.

It is to be observed, that the Battery which enfilades any of the faces which flank the Attac, will also enfilade the covert-way parallel to that face. There should be no less than four guns on each Battery, because the slowness of the *Ricochet* would give the Besieged an opportunity of making *Traverses*, to screen themselves from that dangerous fire; for which reason the fire should be continual.

Besides the Batteries of cannon, there are also Batteries of mortars, in the same line with, and joining those of cannon, to throw shells into the works.

Those for cannon are made with *Embrasures*, and those for mortars, with an *Epaulement*, or breast-work, without *Embrasures*: Trenches are made from each end of the Batteries to the first Parallel, or to the next Approaches, to go to, or from the Batteries without danger; and a passage is made over the Parallels for carrying the guns and mortars that way to the Batteries, which are afterwards clear'd to preserve the communication from one part to another. When guns are fired *à Ricochet*, they are loaded with a small quantity of powder, and the gun is elevated about six or seven degrees above the level, that the shot may just rise above the opposite parapet, and after alighting bound and roll along the rampart behind the other parapets, for which purpose measures of several sizes are made, to find the proper charges, which once found is not to be alter'd.

M. *Vauban* was the first inventor of the firing *à Ricochet* with guns, which has since been applied



to mortars and *howitzes* with great success: It is certainly the most advantageous manner of firing that can be imagined; as it requires but little powder, it does but little damage to the guns, yet incommodes the Besieged in their works, without making a great number of traverses, which are very troublesome in stopping the free communication of one part with another, yet not entirely prevent the effect; and when mortars and howitzes are fired in that manner, their shells do the execution both of shells and shot.

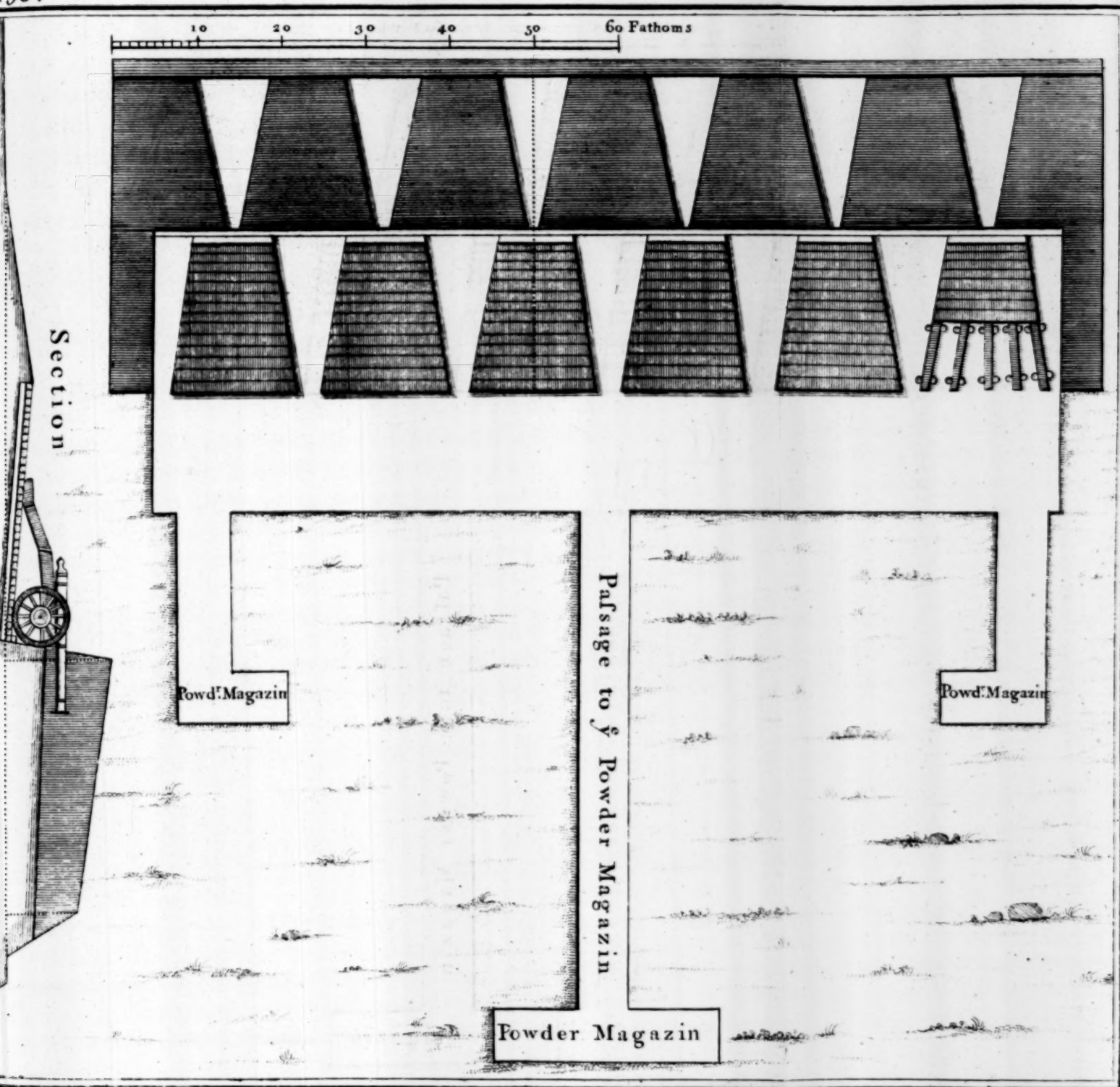
### CONSTRUCTION of BATTERIES.

PLATE VII. **T**HE Construction of Batteries belongs to the officers of artillery, altho' here in *England* the Engineers are employed in these works, whose Commander in chief should therefore consult with the Director about their places, which when known, Trenches are carried from the Parallel, or Approaches, quite round them \*; then a detachment of pioneers take the earth from the side of those Trenches, next to the Town, and throw it backwards, to raise a para-

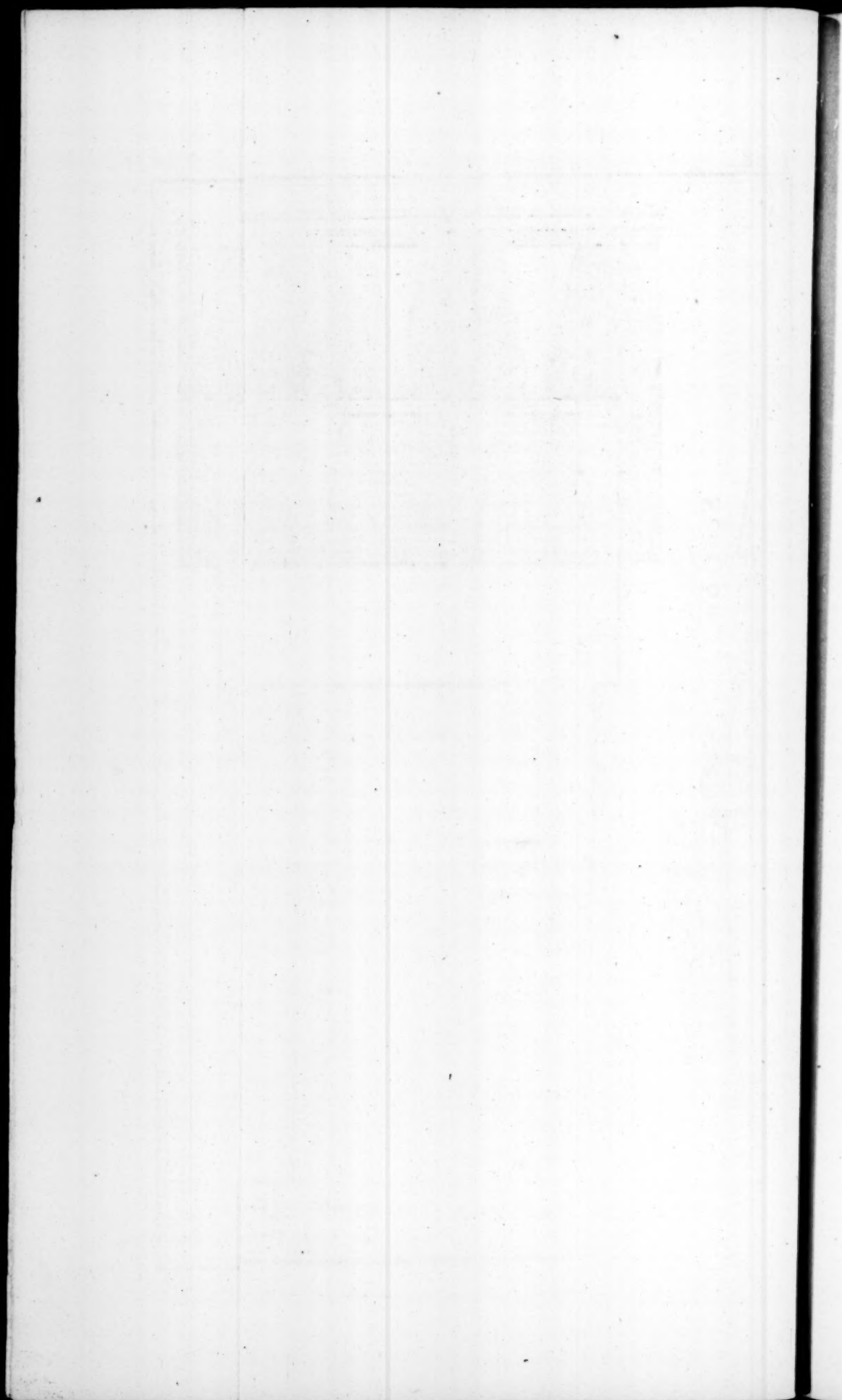
\* The *French* have a great number of Artillery Officers called Commissaries, independant of the regiment; who are employed in the managing and placing stores in the park; to make and command the Batteries. The King pays commonly 300 livres for every gun placed on the first Batteries, 500 for every piece placed on the covert-way, and a 1000 for each placed in a ravelin, or counter-guard, or any other outwork; he pays besides 10 or 15 livres a day for each piece while fired, by way of subsistence money: Out of these sums the expences of making the Batteries, which are very considerable, in regard to the wood for making plat-forms, fascines, and paying the workmen. He pays 500 livres for each mortar; 16 livres a day for subsistence money, and but 10 for pieces fired *en barbet*. What remains at the end of the Siege, is divided amongst the officers employed in proportion to their rank (the commander excepted) who receives a gratification from the Master General.

pet,









pet, or breast-work: In the mean time the gunners \* prepare the materials for the platforms. The breast-work should be 18 or 20 feet thick, and seven and a half high, lined with fascines made for that purpose, well fastened together with pickets or flakes.

There are generally 200 pioneers and 20 gunners at making a Battery of 10 guns, and for larger or smaller in proportion. As soon as a sufficient quantity of earth is thrown up to cover the gunners within, they make a small Trench of five or six Inches deep from one end to the other, in which they lay the first fascine, and fix it well to the ground with pickets; the next is laid at the end of it, and is fixed to the ground in the same manner, and so continues to the end of the Battery. Then they begin another row at the top of the first, fastened to it with pickets, taking care that the ends of the upper fascines do not correspond with those underneath them, for which reason some fascines are made shorter than others. When the second row is finished, they lay a third, and continue in this manner the work quite up to the top, observing to give it a little slope, that the fascines may better support the earth, and to turn the ends of the bindings inward, which gives a neatness to the work.

When the fascines are raised three feet above ground, there must either be left openings of two feet wide at proper distances for the embrasures, or the work may be carried up entire to the top, and the embrasures opened afterwards, by cutting the fascines with saws.

\* In *England* these Works are done by the Engineers.

If the Battery happens to be flanked by any of the works of the town, the flanks must be cover'd by a parapet of 10 or 12 feet thick, and made in the same manner, and at the same time as the breast-work.

The distance from the center of one embrasure to that of the next, is generally three fathoms or 18 feet; so that a Battery of 10 pieces of cannon is 30 fathoms long on the inside; the embrasures are two feet wide within, and about nine without, slanting outwards about a foot and a half.

Whilst the earth is throwing up for the parapet, the gunners should lay the platforms, as soon as there is enough thrown up to cover them, beginning to lay five Joists or Sleepers longways from the parapet, securing them on both sides with stakes; then the Hurter is laid next to the parapet, which is a piece of timber about Six inches one way, and five the other; and after that the planks of about three inches thick. The earth must be well ramm'd betwixt the joists, and round the edge of the platform, to make it strong and firm. The platforms are 15 feet broad behind, 9 before, and 18 long, with a slope forwards, of about nine or ten inches,

When there is a sufficient quantity of earth thrown up for the parapet, and smoothed, the gunners begin to open the embrasures from within, leaving always some earth before them as long as they can, to cover them against the fire of the place.

They begin to plant two pickets, one within and the other without, to mark the center, or middle line of the embrasure, and then plant two more on each side, to mark the openings within and without:

without: This done, the earth within the embrasures is removed for the space of 10 or 12 feet, and fascines laid, well picketed, to secure the sides of the embrasures; and when this is done, they make trenches on both sides, just wide enough to lay the fascines, and leaving the space of three or four feet in the middle, to cover them; and when these fascines are laid, and the guns ready to fire, the remaining earth in the embrasures is taken away, which is called *Unmasking* the Battery.

A stuff gabion is laid across the embrasure on the inside of the parapet, to keep off the musket-shot; and the gunners generally make use of a piece of wood three inches thick, just fitting the inside of the embrasure, for the same purpose, whilst they are loading or cooling the pieces.

They also make use of an *Aim Frontlet*, which is placed upon the vent field of the gun, when they point it, and which is a piece of a plank three inches thick, a foot long, and 7 or 8 inches high, with a round cavity underneath, to fit the outside of the gun, and having a small slit, to see the object through it.

About 20 or 30 yards from the Battery, towards the parallels, a Magazine is made, about three feet under ground, to hold the powder and loaded shells. Its sides and roof are well secured with boards, to prevent the earth from falling in; a door is made to it, and a double trench or passage is sunk from the magazine to the Battery, one to go in, and the other to come out, to prevent confusion.

If the passages leading to the magazines are pretty long, there might be traverses made in them, to prevent the plunging into them by the *Ricochet* batteries,



batteries, or they may be made from the ends of the Battery, and so turn in a curve line.

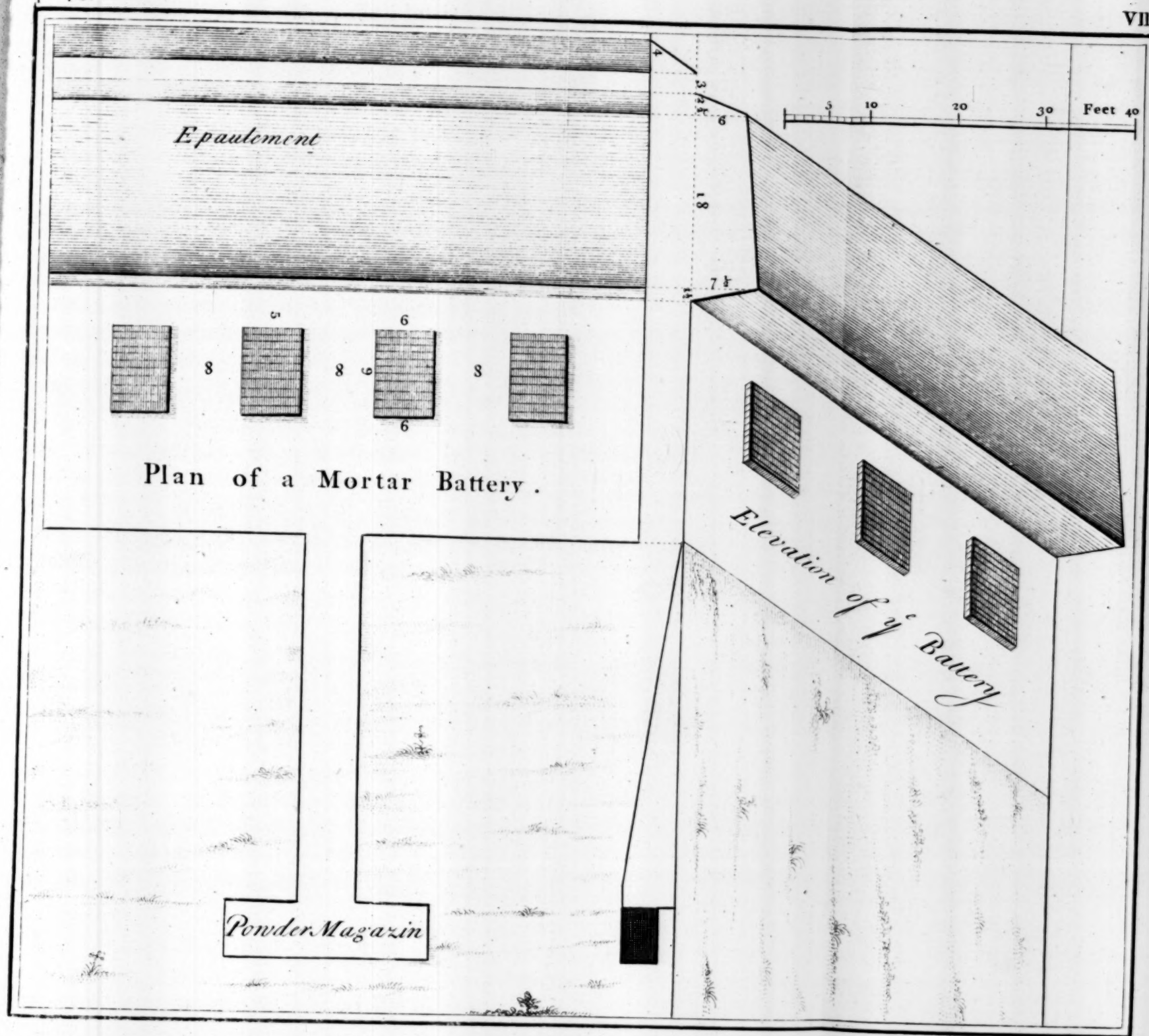
If the Battery is more than of four cannons or mortars, there are generally two or three magazines made, the middle one being much larger than the others, and farther from the Battery. This large one is, as it were, the great or general magazine, from which the lesser are supplied upon occasion; it is prudent to have more than one, so as not to have too much powder lodged together, lest any accident should happen.

It were to be wish'd, that the Batteries of cannon were raised five or six feet above the level ground, to plunge the better into the works; but when the ground is not naturally high, it would be too much trouble to raise it; for which reason they are only made even with the level ground.

As to the mortar Batteries, they differ from the former, only in having no embrasures, and that the slope of the breast-work is made inwards contrary to that of other parapets, their platforms are but six feet square and eight feet asunder. These Batteries may be sunk in the ground, and the earth taken out serves to raise the parapet, which will shorten the work; mortars may also be placed in the Parallels.

The bombardiers plant two pickets or stakes on the parapet in the direction of the object, which serve them to lay the mortars by, as they have no sight of the object itself.

In *England* the mortar-beds are made so very large and heavy, that no platforms are required; but whether it is the best way or not, we shall leave it to the judgment of the Commanders of Artillery. It is certain where the ground is hard and firm,





firm, the Battery is sooner made; but the beds and mortars together, being very heavy, are not easily removed from one place to another, and require much trouble to manage them; and when the ground is soft, the shock of the mortar in firing, makes the direction of the shell very uncertain.

*Of the S A P.*

**I** Have observed, that when the Approaches are advanced so far as the second Parallel, the fire of the Besieged becomes too dangerous to go on uncovered, tho' it is supposed, that all or most of the guns are dismounted by that time; otherwise it would be impossible to proceed farther, for which reason I shall here shew how to proceed under cover, tho' with somewhat less speed, yet with greater security, than when uncovered.

The advantage of this work is, that it may be continued day and night, since <sup>PLATE IX.</sup> the workmen are covered on the flank by gabions filled with earth, and fascines over them, and on the front by mantlets or stufed gabions, which they roll before them as they advance.

The sappers are divided into brigades of eight men each, to relieve one another, and these brigades are subdivided into four and four; so that whilst four of them carry on the work, the other four furnish them with the necessary materials; and when the first four are tired, the others relieve them, the first furnishing those in their turn with materials.

The Engineers shews the first sapper where to make an opening in the Trenches, and gives him directions; then he begins by making room  
for



for the mantlet or gabion, and sets the first gabion with the points upwards to place fascines on them afterwards; he then fills it with earth, giving it every now and then a blow with the spade or mallet to settle the earth; when this gabion is filled, he advances the mantlet or stufed gabion, to make room for another, which he places by means of the iron hook and fork designed for that purpose; and this he may do without exposing himself. When this gabion is filled, he places another, and so on; then the second sapper fills the interval betwixt the gabions with sand bags fill'd with earth, or with sap faggots.

The first sapper makes a Trench of 18 inches deep and as wide, the second makes it six inches, and widens it as much; the third makes it six inches more, and widens it as much; and the fourth does the same; so that all four together make a trench of three feet wide, and as much in depth; the earth of which will serve to make a parapet strong enough to resist musket-shot.

When a sufficient number of gabions are placed, the third and fourth sappers lay two fascines over them, and press them down, so that the stakes of the gabions may keep them firm; then another is laid over the former, and fasten'd to them with pickets.

When the first sapper is tired, he retires behind, and the second takes his place; they continue thus alternately to relieve each other, that they may equally share the danger and labour.

As this work is carried on with all possible speed and diligence, in two or three hours, the sappers will be tired; then the other four of their Brigade, who furnished them with materials, take their places,

Plan of a Sap



Front of a Sap



Back of a Sap .



Sections .



places, and continue the sap in the same order and manner as the first; who furnish the others in their turn with the necessary materials: These four being tired, the others take their place, and so on alternately, till the Brigade is reliev'd, which ought to be done every six hours.

Not only both Approaches at the right and left are carried on at the same time, but also the second Parallel to the right and left of these Approaches; and when those who work in the Parallel come to the capital produced of the ravelin, the Approaches to the ravelin are also carried on at the same time, so that the sappers work in five or six places at once; and special care should be taken that they do not want any thing necessary, that the work may be continued with all possible speed, and without interruption.

When this work is carried on to some distance, other workmen are ordered to widen the sap to 12 feet, and from thence forward it changes it's name of sap to that of Trenches.

As this kind of work is dangerous, and requires skill in the workmen, they are paid according to measurement, more or less, in proportion as it is dangerous, from half a crown a fathom in length, to two guineas; and if there are any kill'd, the survivors of the Brigade receive their pay; by which means it has sometimes happened that one or two men have received the pay of 24 at the rate of a guinea a-piece. And tho' this kind of work may seem to go on but slowly in comparison to that which is carried on uncovered, yet by its continuance both night and day without intermission, it is quick enough; besides, as it is done with much  
less

less danger than the other, it is generally made use of as soon as the Approaches come to the second Parallel.

Of PARALLELS.

PARALLELS are useful on account of their joining the two Attacs together, so as to afford mutual succour to each other; they serve as places of Arms for the guards of the Trenches, who by that means are under cover, and at hand to support the workmen upon all occasions. The first Parallel is always made within 300 fathoms of the covert-way, whether the Trenches are opened nearer or farther from the place; if it can be made nearer, it would be so much the better. The second 140 fathoms from the first; or if the garrison is weak, it is often made close to the glacis. After the second Parallel, the Approaches being so near that the Besieged may sally out whenever they please, without any danger of their being cut off in their retreat, it is necessary to make at every first or second turn of the Approaches, a kind of half Parallels, or places of Arms; so that a part of the guard being placed there, may be near at hand to support the workmen in case of a sally or an alarm.

The third Parallel is always made near, or upon the glacis, but when the Garrison is very numerous, and have an active Governor, or when the *Ricochet* Batteries cannot be used on account of some river, morasses, or the Town lying on a hill, or rising ground, much above the level of the country; it is made within thirteen or fourteen fathom of the saliant angles of the covert-way; and as the sallies of the Besieged become more frequent than ever, this Parallel is on that account made wider and deeper,



deeper, as also with more care than the rest of the works, especially as the troops designed for the Attacks of the covert-way, and other out-works, are to be placed there; for which reason, its parapet is made with steps, that the troops may march out in order of battle without confusion.

Sometimes it is necessary to make a fourth Parallel, within six or eight fathoms of the covert-way, especially when the Garrison is very numerous, or when all their Guns cannot be dismounted, or when the Besieged erect new Batteries by night, in the room of those that were destroyed by day.

*Of* SALLIES.

**I**T has been shewn how the Approaches, and the other works are to be made, as far as the third Parallel, without mentioning any other obstruction from the Besieged, than the fire of their Guns and small Arms; but it is to be presumed, that they will not be so remiss as to suffer themselves to be thus streighten'd without making use of all the means in their power to prevent it, and to prolong the Siege. And as Sallies are one of the principal, they will not fail to attempt them, and endeavour to destroy the Trenches as often as they possibly can. It will not be improper therefore, to shew how to prevent the effects of them, and even to render them, if possible, advantagious to the Besiegers.

As the garrison is but small in comparison to the Army of the Besiegers, the Trenches are, or ought to be so well guarded, as to be able not only to resist any Sally, even though composed of the whole garrison, but also to repulse them with the utmost vigour, and a considerable loss; a Sally therefore never succeeds but by surprize; so that if the Besiegers

siegers are upon their guard, especially when the head of the work is at some distance from the place, it will hardly be possible for the Besieged to undertake any thing against the Trenches. But should they be so inconsiderate as to Sally out, notwithstanding that the Besiegers are apprised of it, it will undoubtedly turn to their great disadvantage and confusion. The intent of Sallies is to fall upon and destroy a part of the Approaches not quite finished, or not well supported, to nail up the Guns upon the Batteries, or to surprize a part of the guard in the Trenches; for which reason special care must be taken to watch and look out so well, that the enemy may not approach unperceived; and as soon as they are heard or seen, the workmen at the head of the Trenches are ordered to retire, and notice is given to the guard both in the Parallel, and in the Approaches, to be ready to receive them with a smart fire, which being well executed, will not fail of putting them in confusion, and then they must be immediately charged both in front and flank, taking care however not to pursue them too far, for fear of the fire from the covert-way, and other out-works of the Place, as soon as the enemies are under cover; the garrison generally waiting for such an opportunity.

Notwithstanding all the care that can be taken, the private men will be remiss in their duty; and therefore, an officer, serjeant, or corporal, should continually watch over the centries, who are posted to prevent a surprize; especially in a dark or rainy night, or early in the morning when the soldiers are fatigued, and so less upon their guard; it being chiefly at those times that the enemy undertakes those Sallies.

The

The works become more exposed to be insulted in proportion as they approach the Town; for which reason no work should be undertaken without being well supported, and for that purpose, as already said, the places of Arms are made; from thence the works are maintained till such time that the third Parallel is quite finished, which will so streighten the Besieged, as not to be any longer in a condition to Sally without the utmost danger.

Sallies are never made in the day-time, but by a presumptuous enemy; for then they are easily repulsed, unless the garrison is very numerous, or the Army of the Besiegers so weak, as not to be able to furnish a sufficient guard for the Trenches; in such cases a General ought to consider whether he is in a condition to continue the Siege.

A garrison may be in a state to insult or attac the Trenches after having received a strong reinforcement, or when the Besiegers are obliged to send a considerable part of their Army upon some other enterprize. It is then at the option of the General, either to continue or raise the Siege; if it appears that the Army suffers greatly without any certainty of taking the Place, he ought to retire.

But suppose that measures have been so well concerted by the General, as to prevent in all appearance the danger of being disappointed; then if parties of 10 or 12 men headed by a serjeant, are ordered to range in the night between the Trenches and the Town, to watch, and to discover the enemy, in case they come out, and give notice to the guard of the Trenches; this will defeat their design. These men must lie on their faces as near the covert-way as possible, remaining in profound silence till they hear or perceive some motion, then

E

send

send one of them immediately to the guard, whilst the rest continue there as long as they can be concealed, to see which way the enemy direct their course, and then retire. This may be easily executed without much danger, and will secure the Besiegers from all surprise.

When the works are advanced to the third Parallel, and before that Parallel is finished, if the enemy should then Sally out on a sudden, and fall upon the workmen, they must be ordered to retire, to let the guard fire briskly upon them, without minding the overturning a dozen or two of gabions; for the galling fire of the small Arms, will soon oblige them to retire, and then the workmen must return instantly and repair their works, which may soon be done; whereas the Besieged are not in a condition to repair their loss so quickly.

*Of the LODGMENT on the GLACIS, and taking of the COVERT-WAY.*

PL. X. **I**T has been shewn how the Approaches are conducted as far as the third Parallel; but as it is hardly possible to proceed any farther, without being seen or enfiladed by some work or other of the Town; it is necessary to make the Trenches from thence forward, much deeper than before, with traverses in them, from distance to distance; by which the enfilades will be prevented in part, tho' not entirely.

The figure of these kind of Trenches varies according to the different circumstances or position of the works which defend the glacis: Sometimes they are made partly with short turns, or Zig-zags, like the former, and the rest with a direct sap over the  
ridge



ridge of the glacis, before the saliant angles of the covert-way, or otherwise, by making a large oval traverse, as in this Plan; and then they are carried directly forward over the ridge of the glacis as aforesaid, in the following manner.

Two sappers roll each a mantlet, or stufed gabion before them, each carrying on a sap, one on one side of the ridge, and the other on the other, so that the interval between the Parapets may be ten or twelve feet; and then they make traverses from distance to distance of about eight or ten feet thick, with a passage round each end, covered by two or three gabions.

This work is called *Double Sap*, the Plan of which see in Plate V. When it is advanced within thirteen or fourteen fathoms of the saliant angles of the covert-way, that is, within throw of grenades, two branches are made to the right and to the left, such as a, which M. *Vauban* calls *Cavalliers* of the Trenches: They are nearly perpendicular to the produced branches of the covert-way so as to enfilade them, of about twenty fathoms long, eighteen feet wide, with their Parapets raised by three ranges of gabions placed in steps-fashion, so that from thence the covert-way may be plunged into every where; they have little turns at the end, to prevent being enfiladed by the places of Arms in the re-entring angles.

M. *Vauban* judiciously observes, that the Approaches carried along the ridge before the saliant angles are only enfiladed by three or four men placed in those angles, and therefore this is the securest place to make the Approaches. From these places of arms or *Cavalliers*, the double sap is continued quite up to the angles of the covert-way, in

the same manner as before; and to prevent the enemy from throwing stones and grenades into them, they must be covered with blinds and fascines.

When these *Cavalliers* are once finished, it will be dangerous for the enemy to remain any where in the covert-way, except behind the traverses, as they will be every where else seen and enfiladed from them. I suppose that the *Ricochet* Batteries are playing continually into the covert-way, and adjacent works, whilst the lodgments are carried on upon the glacis, otherwise the enemy will obstruct them to such a degree, and fire upon them so briskly, that it would be almost impossible to advance a step. Here a gallant Governor may with the greatest advantage oppose the Besiegers, and dispute every inch of ground to the last, as being so near the covert-way, where his troops may do them great mischief with little or no danger, were it not for the *Ricochet* Batteries, and consequently this is the place where the Besiegers may make the best use of those Batteries.

The Approaches being advanced to the saliant angles of the covert-way, a large oval traverse is made, so that the trench round it may take in a part of that angle, by which the enemy may be drove out of that place; from whence the Trenches are continued both ways along, and within three fathoms of the covert-way towards the places of Arms.

The saliant angles of the covert-way being taken, and lodgments made in them, the Besieged must be drove from behind the traverses next to them; by piercing into the passages behind them, from  
the

the opposite Trenches, and making lodgments there, which are afterwards carried round the angle of the counter-scarp. This done, there will be no place left to the Besieged in the covert-way besides the places of Arms at the re-entring angles.

When the Trenches are advanced to about two thirds of the way, branches are carried on both sides of the places of Arms, so as to meet, and that both together make a right line nearly, in which Batteries, such as *b*, for throwing of stones are made; which, when finished, will serve to drive the Besieged out of the opposite places of Arms. But when there are stone redouts in these places, which are covered, the stones will have no effect on them, and therefore shells must be thrown to ruin them, which when done, a detachment of about 200 grenadiers is sent to attac the Places of Arms sword in hand. So soon as the Besieged are retired, workmen headed by Engineers are sent to make lodgments in them, which are afterwards joined to those on the glacis, as likewise to those which are carried round the places of Arms.

If the garrison is strong, and the Governor has courage and conduct, he will not let the Besiegers make these lodgments quietly, but on the contrary, will return as often as he can, to disturb and destroy them, till they are quite finished, and a sufficient number of men placed to defend them.

These places of Arms being once taken, and the lodgments in them finished, the Besieged will hardly venture to return any more; Batteries are made along their gorges, in a round form, to fire upon the tenailles, curtain, and the faces of the opposite Bastions.

*Of MINES.*

**T**HE Art of Mining being independant of the Attac and Defence of Places, I shall treat of it more distinctly afterwards, and only mention here a few particulars, so far as relates to the Attac, without entering into the manner of loading and making the Mines.

What has been said relating to the works made on the glacis and covert-way, is only with regard to those above ground, and to the resistance the Besiegers meet from the enemy in those works. But as there are few Places which have no Mines, and when the Besieged are obliged to yield to the superiority of the Besiegers, both in men and guns, and all hopes of recovering the lost works, they will not fail to spring their Mines, as the last and only resource left to retard the progress of the enemy; and thereby blow up both them and their works; by which they oblige the Besiegers to attac those works again, and make new lodgments therein, which they thought secure before. It is therefore necessary to shew how to find out their Mines, to prevent their effect, or destroy the greatest part of them, and so be upon a par with the Besieged in that respect.

To effect this, shafts or pits are sunk in or near the third Parallel, of 7 or 8 feet square, and about 18 or 20 deep, if the ground will permit it; from thence galleries are carried on towards the covert-way, of 4 feet wide, and 5 high, endeavouring to meet with those of the enemy, by boring the sides, bottom, and roofs of these galleries with a long iron needle or augre, from time to time, to find



find out whether the enemy's galleries or miners are near ; if they are found to be underneath, an opening is made down into them, and live shells thrown in, either to drive them out, or destroy them ; if on the contrary they are found to be above, a small mine must be made to break them ; but if they are at one or the other side, notice must be taken whether they approach or recede. In the first case, a hole is made, and a pistol clapt in it, ready to fire at them, so soon as they are within reach ; and in the second case, a gallery must be carried on towards them, within a small distance, and then a small Mine should be made, to burst their gallery, and destroy the miners.

The Besiegers should carry on their galleries directly under their works above ground, to secure them from the enemies Mines ; and if those of the Besieged are not discovered, as it may easily happen, branches are made on the right and left, with small Mines at the ends of them, which being sprung, will hardly fail to destroy most of the Besieged's Mines and Galleries.

Notwithstanding all the care that may be taken, it is not to be presumed, that all the Mines of the Besieged should be rendered ineffectual, and therefore, so soon as they spring any of them, workmen are immediately sent to lodge themselves in the pits. If water could by any means be conveyed in the Besieged's galleries, it would effectually spoil them, as it happened at the Siege of *Turin*, where many Mines were rendered useless that way.

The Besieged generally place Mines within 4 or 5 fathoms of the covert-way where they know that the Besiegers will lodge themselves, not daring to make them nearer, for fear of breaking the Palli-

fades; the Besiegers should therefore make Mines thereabouts also, to render the others useless, and thereby make partly their own lodgments. This precaution should in my opinion be taken wherever there is a suspicion of any Mines of the Besieged, which consequently would prevent any great mischief from them, especially as their effect is but inconsiderable, except directly upwards only.

The Besieged will endeavour also to the utmost of their power, not to part with an inch of ground till constrained by the last necessity; and when they have done all they can above ground, to maintain it, will at last spring their Mines; for which reason the Besiegers should act with the utmost caution, not to be surprized, and to get masters of as much ground with as little loss as possible.

If notwithstanding all that has been said about taking the covert-way, the Besieged still keep their ground, in the places of Arms, and behind the traverses, the Besiegers must endeavour to oblige them to spring their Mines near the saliant angles, or else must make Mines there themselves, and blow them up; and so soon as this is done, send workmen immediately to make lodgments in their ruins, securing those, as much as possible, which are joined afterwards to the double saps on the ridge before the saliant angles, and particular care must be taken to make traverses every where, to secure them from being enfiladed. When these lodgments are extended to the traverses next to the saliant angles, and the enemy still keep their ground behind them, as there can be but few under cover there, a party of grenadiers must set upon them on a sudden to drive them away, sword in hand; this done, some of these grenadiers should endeavour to find out  
the

the entrance of the Besieged's galleries, and cut off the matches, to render them useless; in the mean time workmen are sent to lodge themselves in the passage round the traverse, and from thence carry a lodgment round the counterscarp before the saliant angles, till they meet each other; these lodgments must be made very deep, and cover'd with blinds and fascines, to prevent the effect of the grenades and stones that may be thrown in them by the Besieged.

Whilst this is doing, the cannons and mortars must incessantly fire upon all the defences of the Place, endeavouring to silence the fire of the Besieged, and to drive them, if possible, from behind the parapets of the faces of the opposite bastions and ravelins.

ATTAC of the COVERT-WAY, *sword in hand.*

**W**HEN a Town is not strongly garrisoned, or the General thinks the foregoing method too tedious, the Attac may be made as follows.

The third Parallel in this case should be made at least as forward as the midway of the glacis, having its parapet made step-fashion, as before, that the troops designed for the Attac may pass easily over it, without any confusion. A great quantity of fascines, gabions, and other materials, must be got ready, and placed at the back of this Parallel. A strong party of grenadiers is ordered, and placed in this Parallel, five or six deep, and the workmen behind them on the reverse of the Parallel, having their tools and materials by them. Likewise all the adjacent parts of the Trenches must be well furnished with troops to support the grenadiers, if there

there is occasion, and fire wherever the enemy appears. The grenadiers must be provided with hatchets to cut the pallisades, in case the guns should not have broke them.

Before the Attac is made, the guns and mortars are to fire briskly for some time at all the defences of and into the Covert-way, to drive the Besieged from thence, and to break the pallisades, if possible, and to plough the ridge of the glacis in such a manner, as the troops may enter the Covert-way without much difficulty; then the guns cease, to cool. When this is done, the signal is given for the Attac, upon which all the troops begin to move, and passing quickly over the parapet of the Parallel, march directly to the Covert-way, which they enter either thro' the sally-ports or passages made by the guns, or else the grenadiers cut down the palisades with their hatchets; and being entered charge the enemy so vigorously as to oblige them to retire; then the Engineers set the workmen about making a lodgment on the ridge of the glacis, opposite to that part of the Covert-way which the Besieged have abandoned.

These lodgments are made with gabions and fascines, in the same manner as the saps; and traverses are made every where to prevent the enfilades. The troops keep behind the workmen, and kneel down, till the lodgment is so far advanced that they may retire into it. Whilst this is doing, the Batteries fire continually upon all the defences of the Covert-way, either to silence or abate the fire of the enemy, as much as possible; and to oblige them to think more of their own safety, than opposing the Besiegers.

If



If the Besieged should return to the charge, as probably they will, and overthrow the work and maintain their ground, nothing but a superior force can make the Besiegers masters of the Place.

When the Besieged find that they cannot possibly hold out any longer, they will set fire to their Mines and retire; upon which workmen are immediately sent to make a lodgment in their ruins, which is afterwards joined to the rest of the Trenches.

This was the manner of attacking the Covert-way formerly; but since M. *Vauban*, by his great experience and knowledge, has brought the Art of Attac and Defence to so great a perfection as it now is, the Covert-way has very seldom been taken sword in hand. His chief study being always to preserve the troops as much as possible, and never to expose them to any danger, without the utmost necessity.

Yet, when a garrison is but weak, and the Army of the Besiegers very strong, the guns of the Besieged may be silenced, and the palisadoes torn to pieces by the *Batteries Ricôchet*; in such cases the Covert-way may be attacked with open force, sword in hand, and that without much danger; but if the garrison is strong, and commanded by a Governor who knows his business, it would be imprudent to make such an Attac; for it would prove one of the most bloody actions of the whole Siege.

The *French* lost 3000 men in the Attac of the Covert-way, sword in hand, in the last Siege of *Fribourg* in *Brisgaw*.

BATTERIES *on the* COVERT-WAY.

**T**HE Besieged being drove out of the Covert-way, the next thing to be done is erecting Batteries, to make a Breach, and ruin the defences.

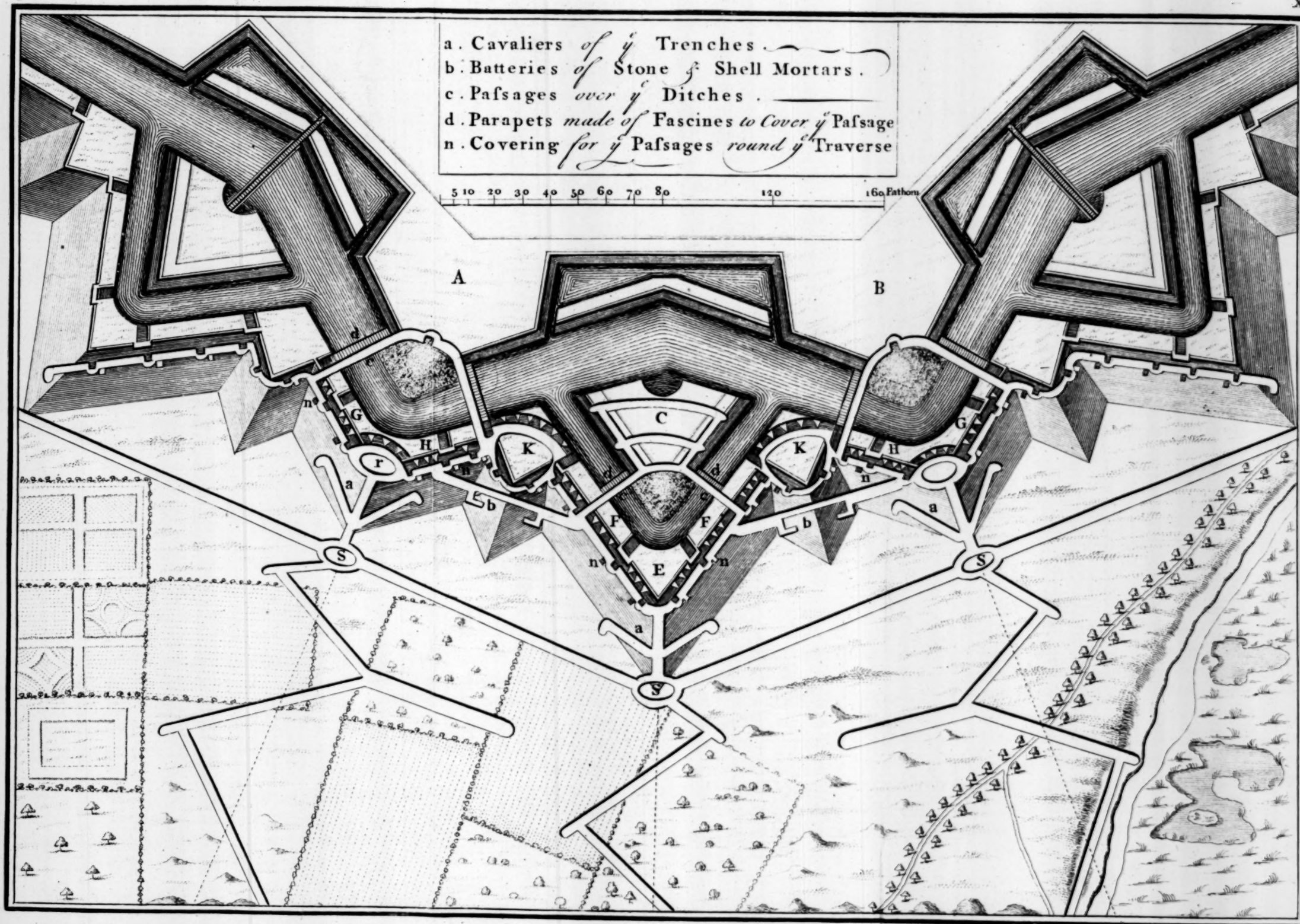
As the ravelin C is to be attacked first, and  
 PL. X. is flanked or defended by the faces of the bastions A, B, opposite to its ditch; the first Batteries to be made are those marked E, F, the former to ruin the defence of the ditch, and the latter to make a breach in the ravelin. Each of these Batteries should contain four or five twenty-four pounders at least: sometimes the Batteries F, F, which batter the ravelin, are also used to batter the faces of the bastions A, B; but as this cannot be done without battering the ravelin too near the saliant angle, it will be much better to erect Batteries for that purpose.

If the faces of the bastions, which defend the ditch of the ravelin, were well enfiladed by the *Ricochet* Batteries, there will be no occasion for the Batteries E, E.

Whilst these Batteries are erecting, others also, as G, H, must be made to ruin the flanks of the bastions A, B, of as many guns as can be placed opposite to them, as also some to batter the opposite faces.

It is to be observed, that the best place for making breaches, both in the ravelin and bastion, is about 15 fathoms from the saliant angle; so that battering on both sides of the angle, the breach will become spacious and large; whereas, on the contrary, if the breach were made too near the angle, it would become too small and incommodious.

The





The Batteries made in the gorges K of the places of Arms, serve to fire obliquely at the faces, curtains, and tenailles, as mentioned already, or to place mortars, for throwing shells and stones into the works.

When these Batteries are erected, passages over the trenches are made to bring the guns there; which when done, are again opened, so as not to interrupt the free passage of the Trenches.

All these Batteries are made on the ridge of the glacis, within three fathoms of the covert-way, which interval serves to make the parapet or epaulement; and as the guns, which are to make a breach, should fire as low as the bottom of the ditch, the embrasures must be made sloping downwards accordingly. The guns intended to make a breach should always fire together, or in salvos, and as nearly in the same place as possible, and continue so till the wall is quite pierced, which may be known by the earth's falling. They must begin firing at first as low as they can, and batter the wall nearly in a horizontal line, as far as the Breach is intended to be made; afterwards fire something higher, in the same manner as before, and continue so to do, till the wall tumbles down; for should they fire at first too high, the rubbish would cover the lower part of the wall, so as not to be broke afterwards, and the Breach would thereby become impracticable.

It was formerly the custom, to load the battering Pieces with a quantity of powder, equal to half the weight of the shot; but experience has shewn that one third of the shots weight, and perhaps less is sufficient. For the *French* used no more in the last war; and it is manifest that a shot with a very great velocity,



velocity, enters the wall without shaking it, whereas if the velocity is just sufficient to enter the wall, it makes a larger hole, and shakes it very much at the same time. This is confirmed by experience; for if a stone is thrown against a window or any other glass, it will break it into many pieces, but a pistol shot will only make a small hole without breaking it into pieces.

It has likewise been found, that battering-pieces need not be so heavy as they have been made hitherto; for instead of making a twenty-four pounder to weigh 5100, if it weighs 2400 it is sufficient to resist all the firing in a Siege, which diminishes both the charges, and the trouble of bringing them to the Battery, considerably, as shewn in my *Treatise of Artillery*.

The modern and the shortest way to make a Breach, is to pierce the wall with guns, so as to make a hole for two or three miners to lodge themselves in it, who are sent over the ditch, as soon as it is dark, in boats, if the ditch is full of water, and make three or four small Mines under the parapet, which when sprung, will at once make a Breach sufficiently large, and wanting nothing but to be cleared, in order to make an Assault.

As the Besieged will not fail endeavouring to destroy the Batteries near the covert-way, where they have generally mines ready made, it would be prudent to make galleries quite round them, either to destroy those mines, or to render them useless.

#### DESCENTS and PASSAGES over DITCHES.

**W**Hilst the Batteries on the glacis are erecting, preparations are made for the passage over the ditch of the ravelin; which may be dry or wet;

wet; and either of them requires a different manner of passing. I shall explain both ways separately in their order.

If the ditch is dry and pretty deep, the descent is made by galleries, or a covered sap, underground, having its entrance about the middle of the glacis, and coming out near the bottom of the ditch, opposite to the Breach; these galleries are made with wooden frames, and boards to support the earth at the sides and roof, and PL. XI. to prevent its falling in.

To find the slope of the descent, so as to come out nearly at the bottom of the ditch, its depth must be taken near the counterscarp with a plummet, and the distance from the entrance of the gallery to the ditch must likewise be measured; then the horizontal distance of any part from the entrance must be to the vertical descent, as the length of the distance from the said entrance to the ditch is to its depth. For instance, if the depth of the ditch is 30 feet, and the distance from the entrance of the gallery to the ditch 120, then by advancing four yards, the slope must sink one; as 120 is to 30, so is four to one. But if the ditch be only 12 or 15 feet deep, then, instead of a gallery made underground, the descent is made by a sap only, beginning in the covert-way, sunk in proportion as it advances, so as to come out nearly at the bottom of the ditch. The sides of this sap are also secured from falling in by boards and stakes, and covered with blinds and fascines.

The Besieged will endeavour to disturb this work, by frequent sallies, and by throwing stones, shells, grenades, and whatever else may serve their purpose;

purpose; especially at the entrance into the ditch. The Besiegers must therefore take such precautions as may render those endeavours ineffectual, which may be done by throwing shells and stones from their Batteries, and grenades from the adjacent works into the ditch, and wherever the enemy appears; and also to fire at them with cannon and small arms; and as they are superior both in respect to men and artillery, they will, in spite of all obstruction, be able to continue their work.

When the Descent is made, the passage is continued with sapping, and the side next to the place is covered with a strong parapet.

There are generally two or three descents made into the same ditch, at once, to help and support each other; and as the Besieged frequently make use of small mines to blow up the saps, and sally out at the same time, to destroy or retard the work, some companies of grenadiers are placed near at hand, to fall upon them as soon as they appear, the Batteries playing continually at all the defences of the place, that those within may have enough to do to think of their own safety, without being in a condition to annoy the works of the Besiegers.

Passages are made on both sides of the ravelin, as may be seen in Plate X. so that the Besieged being assaulted on both sides at once, with a great number of men, and thereby overpowered, they will be obliged to retire, and leave the Besiegers masters of the Breach.

If the ditch is wet, and within three or four feet full of water, the descent must begin near the Counterscarp, so as to come out pretty near even with the surface of the water. It is made with a  
covered

covered sap in the same manner before described, and a great quantity of fascines PL. XII. are thrown into the ditch, with stones or some other heavy materials fastened to them, to make them sink to the bottom, and to prevent their being carried away by the current, if there is any. When as many are thrown in, that they come above the water, the sappers range them into beds, with their forks and hooks, as well as they can; then they throw earth upon them, and make them smooth and fit to walk conveniently over. The best means to hasten a work is, to place a good number of men, at four or five feet distance from one another, to forward the fascines and other necessary materials from hand to hand, which will prevent all that confusion, that would otherwise be unavoidable, in the passing and repassing of so many men.

A strong parapet of fascines and sand-bags filled with earth is raised on the side next the place, and if the passage should happen to be over-looked or plunged into by any part of the place, the foremost workmen must be covered with a great heap of fascines, which are pushed forwards as the work advances; and as fast as the passage goes on, it must be covered overhead with blinds and fascines, having earth thrown over them only as far as is necessary.

But if the ditch is full of running water, the passage will be more difficult; for besides the precautions mentioned before, the fascines must be loaded with beds of stones, heavy pieces of wood, and other materials, to prevent their being carried away by the current, and as soon as the work appears above water, the fascines must be fixed, by driving long stakes thro' them into the bottom.



*Note,* If the current of the water is so violent as when stopped to occasion such swellings as might overturn the works in the ditch, then when the passage is advanced within 15 or 20 feet of the Breach, pieces of timber are laid a-cross, and strong planks over them, by which means a passage is preserved for the current, and the works are secured.

### ATTAC of the RAVELIN.

**W**HILE the descent and passage over the ditch are going forward, the Breach is making likewise, so that they are both finished about the same time. If the Breach is made with cannon, care must be taken to begin to break the wall at the bottom of the ditch, as was observed before in speaking of the Batteries. The wall being broke down, as far as is necessary, the counter-forts must be beat down likewise, which as they advance farther into the earth than the wall itself, it will be soonest done by firing at them obliquely. But if the Breach is made by Mines, which is the shortest way, the wall must be first pierced with cannon, and then miners sent to enter into the hole, as above.

The Breach being made, and the ground levelled, materials and tools at hand, the troops for the Assault are ordered to be in readiness at the first notice, and others ready to support them in case of need; the guns and mortars are ordered to fire briskly on all the defences of the Place, which flank the front attacked, both directly and enfilading them by the *Ricochet* Batteries; and a great number of shells and stones are thrown into the ravelin and its defences. Thus having continued  
for

for some hours, the signal is given for ceasing to fire; then the grenadiers march to the Assault, charge the enemy vigorously, and oblige them to retire; after this the workmen, headed by an engineer, advance to make a lodgment on the upper part of the Breach, which when partly done, the troops retire behind it, ready to repulse the Besieged if they should return, which it is presumed they will not fail to do so long and often as they can: but when this lodgment is once so far advanced, as to be in a condition of receiving a good number of troops, the Besieged will have it no longer in their power to disturb them by open force, and therefore they will make use of their Mines, as the last resource left them, if they have not been prevented before-hand; either to blow up the lodgment, or any other place where they perceive a body of men.

When the ditch is dry, the Besiegers may prevent the effect of the Besieged's Mines, by sending some stout grenadiers, with promise of paying them well, from the lodgment on the counterscarp, thro' the ditch round the ravelin to its gorge, at the same time the Assault is making, to discover their entrances, and to cut off the match, whereby the Mines will become useless.

Another way, and more in use, to get possession of the Breach is, by sending two or three sappers to the extremity of the Breach next to the place, where is generally room behind the break of the wall to cover one or two men; there they begin a lodgment for themselves and for two or three more, which are sent after them, who, together, make room for others to follow; and in this manner they proceed, still enlarging their lodgment till the whole

is compleat. It is to be presumed that the Besieged will oppose this work with all their power, either by falling suddenly upon the workmen, or throwing great quantities of grenades, and all kinds of fire-works amongst them. To prevent all this, the workmen are ordered to retire upon the first appearance of an enemy; and the Batteries, as likewise the troops in the lodgments at hand, fire at the same time all together upon them, which will soon oblige them to retire; upon which the workmen return immediately to their work again; and this way of proceeding must be continued till the lodgment is quite finished. If the enemies spring any Mines, workmen are directly sent to lodge themselves in the cavities made by them; and from thence they extend themselves to the former lodgment, or to that part of it which has not been overthrown.

The lodgment at the upper part of the Breach being compleated, others are carried on by saps along the parapet, to get possession of the PL. X. traverses, if the Besieged have made any to shelter themselves from the ricochets, as also to enfilade obliquely the passage between the tennaille and the ravelin. These lodgments must be well traversed from the enfilades to which they are unavoidably exposed, and joined by others cross the ravelin, which serve as a sort of parallels, as likewise to dislodge the enemy from the retrenchments they may have made in the gorge of the ravelin, and to enfilade the communication between the ravelin and the body of the place.

If there should be any palisades placed either round the Besieged's retrenchments or serving for retrenchments themselves; it will be necessary to break

break them with the guns from a Battery that can see them ; or if that cannot be done, small Mines are made to blow them up ; and then the saps are carried on to the gorge of the ravelin, to prevent the Besieged from returning into the work.

*The ATTAC of the BASTION.*

**W**HILST the Attac of the ravelin is making, that of the Bastion is carried on at the same time ; the descent and passage over the ditch and the Breach, are made much in the same manner as those of the ravelin ; but as the ditch is here much wider and deeper, as likewise better defended by the flanks, than there ; the making the descent and passage over the ditch, is also attended with much more difficulty and danger : besides, this being the last place the Besieged have to defend, and where they have all their strength united, they will exert themselves to the utmost of their power, to obstruct and retard it as long as possible : it will not therefore be improper to add something to what has been said already on that account, especially when the ditch is full of water, and has a strong current.

If the ditch is very deep, and the current either rapid of itself, or is to be made so by means of sluices ; the passing it is certainly the most difficult part of the Attac, unless there is a possibility of turning the current into some other channel. If the water is kept up by sluices, they must be found out and destroyed if possible, either by shot or shells ; in short, no means must be left untry'd to break them ; and if that can be effected, it will



extremely facilitate the passage. \* But if the sluice is not to be broke by any means whatsoever, there will be no other remedy than to make a strong dyke cross the ditch, so as to keep up the water to the same height as the sluice does: this dyke is made by laying first a broad bed of fascines, having stones tied in them so as to sink to the bottom, and taking care to make it of sufficient breadth to be able to resist the current; over these fascines are thrown a great quantity of earth and stones mixt together, and the whole beaten or rammed down, and long stakes driven thro' it, if necessary, to make it sufficiently strong.

When this work is advanced within five or six fathoms of the Breach, the current being then confined to a narrow passage, will become extremely rapid; whatever comes to hand is then made use of to finish it; as stuffed gabions, great stones, blocks of wood, old leaky casks, boats or small craft, &c. if any can be had, and pieces of timber for a bridge laid over them.

All this is to be done, and the work carried on within two or three fathoms of the wall, before the Breach is made; then the guns firing against the lower part of the revetement, which falling in the ditch, helps to fill up what remains: but if that should not be sufficient, miners are sent over to blow up as much more earth as is wanting.

If the ditch be deep and narrow, miners are set to work on both sides of it, who by making their mines pretty deep, and loading them with a great deal

\* At the Siege of *Aeth*, in the year 1697, Marshal *Vauban* throwing large shells of 500 lb. found means to break the sluice which kept up the water of the ditch in the front of the Attacks; the passing which would otherwise have been attended with much trouble, but was by this means made easy.

deal of powder, will fill up the greatest part of the ditch with the rubbish.

If there are tenailles before the curtains, the Batteries placed in the places of Arms of the covert-way, must endeavour to ruin them with their guns, throwing likewise a great number of shells and stones into them: and if the Besieged should make any embrasures in the upper curtain to fire obliquely at the passage over the ditch, a Battery of guns must be made in the ravelin near the salient angle, which will command not only the whole curtain, but also the passage between the tenailles; and if this is not yet sufficient to silence the fire of the place, another Battery of mortars must be made in the gorge of the ravelin, from whence such showers of stones and shells may be thrown into all the works, that the Besieged may find but very little shelter there.

But if notwithstanding all this, they maintain their guns behind the curtain, as being cover'd by means of the obliquity of the embrasures; it will be necessary to find a proper situation to erect ricochet Batteries for enfilading the curtain, which is not easily done without having a good Plan of the place; for it is a hard matter to know in what line the curtain lies, and no place but a perpendicular to it will do. But supposing the passage over the ditch and the Breach made ready to march over, the Besiegers must endeavour to establish a good lodgment in the upper part of the Breach, much after the same manner as has been explained in the Attac of the ravelin; that is, by sending small parties thither to lodge themselves, with orders to retire as soon as the enemy appears.

If the bastion has a retrenchment with revetements, the Besieged will defend the Breach with great obstinacy; in such cases a general Assault must be made on both sides of the bastion at the same time, with a sufficient number of men to force the enemy to retire, and these must be sustained by large detachments, posted on the right and left near the descent; and as soon as the Besieged give way, the Besiegers lodge themselves in the Breach, which being finished, saps are carried on to the right and left along the parapet towards the gorge of the bastion, as likewise others towards the flanks or orillons, if there are any, from whence the Besieged may be entirely driven out of the tenailles, if they have not quitted them before.

If the bastions are detached from the body of the place, it will probably be necessary to erect a battery of cannon in the bastion, to batter the inside wall, as likewise to place some mortars there, for throwing shells and stones, under the protection of which, the Approaches may be carried on quite up to the inside ditch, and then a Breach is made in the body of the Place, either with cannon or Mines; this done, the Besieged will hardly venture to stand an Assault, as being too dangerous for them, consequently we may reasonably suppose that they will beat the Chamade.

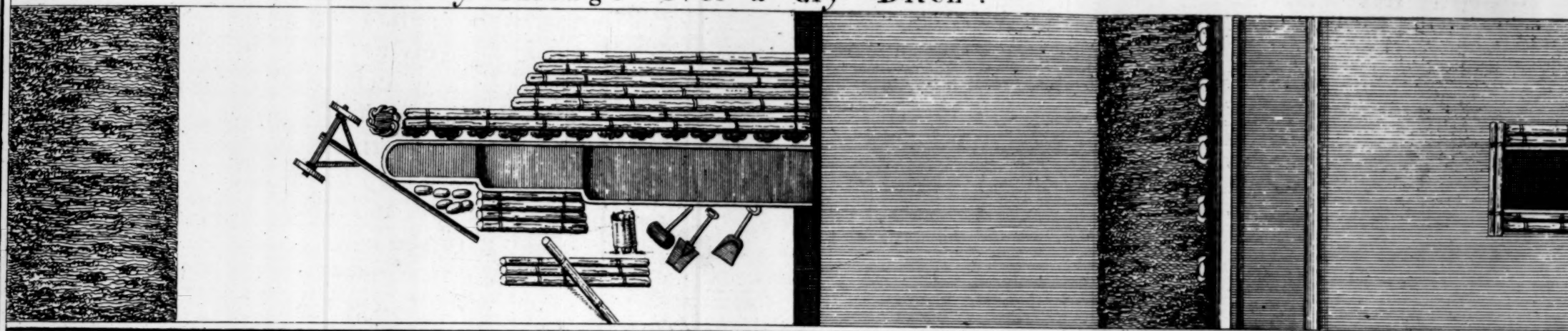
*Of MINES under the BASTION and RAVELIN.*

**W**HAT has been said relating to the Attacks of the Bastion and Ravelin, was only in regard to the works above-ground; it remains now to speak of those made under-ground, which are considerable enough to be treated separately.

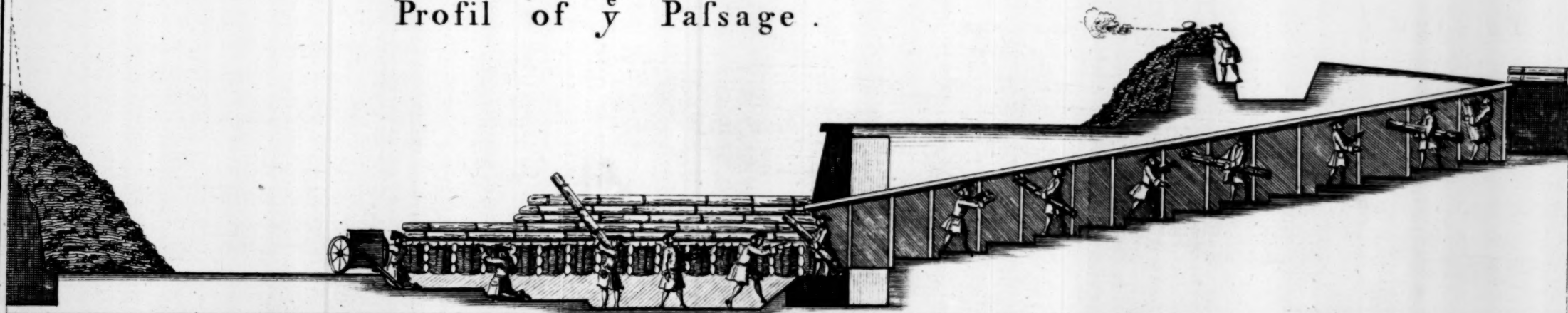
To



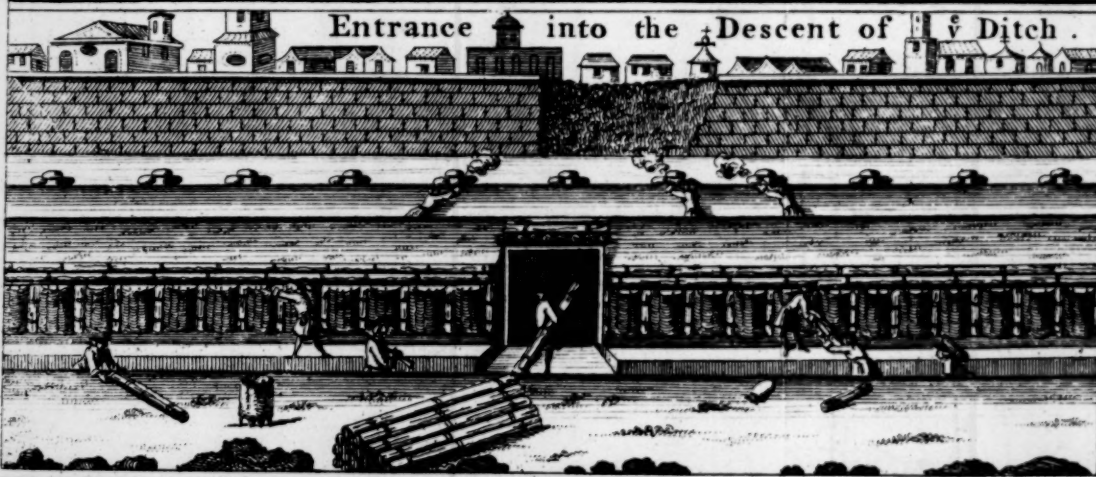
Plan of  $\bar{y}$  Passage over a dry Ditch .



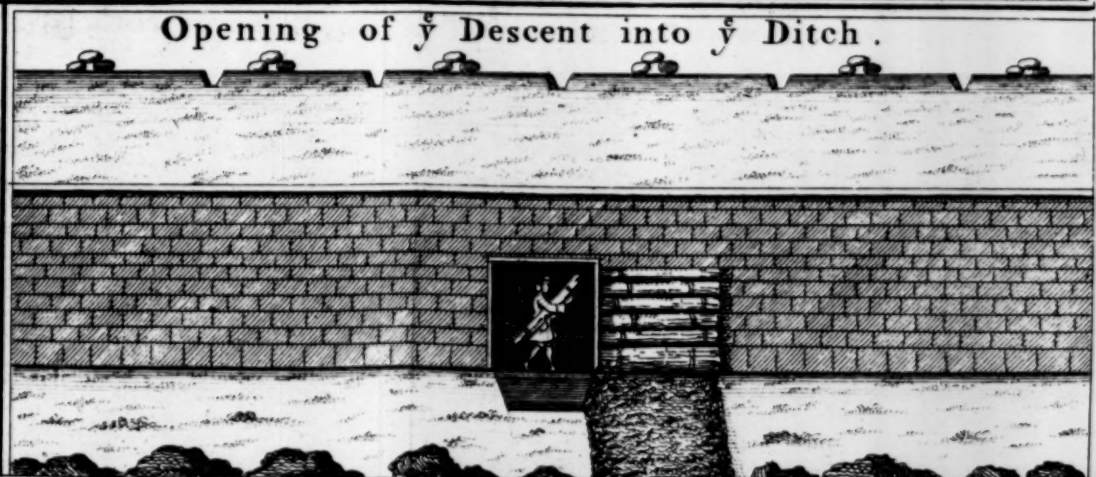
Profil of  $\bar{y}$  Passage .



Entrance into the Descent of  $\bar{y}$  Ditch .



Opening of  $\bar{y}$  Descent into  $\bar{y}$  Ditch .





To fix the miners to the wall when the ditch is dry, a lodgment is made on the opposite counterescarp near the descent, to protect from thence the miners against the sallies of the Besieged ; then the wall is broke with the cannon as near the bottom as can be done, to lodge the miners, and to get under the galleries of the Besieged if possible : the miners remove the rubbish to make room for lodging two or three of them in the hole. Sometimes when the ground is favourable, they carry their galleries from the covert-way under the ditch to the foot of the wall. But if the ditch is wet, the wall is pierced with cannon, while the passage is making, and the miners get over in boats in the dusk ; but as soon as the Besieged discover this, they will endeavour to destroy the miners, by throwing great quantities of shells, grenades, and all kinds of fireworks before the hole ; for which reason the miners must make all possible haste to get under cover ; that will soon be done, if the wall has been thoroughly pierced by the cannon.

If there is any suspicion of Counter-mines behind the wall, the miners retire so soon as the rubbish is removed, and the cannon fire again into the hole, endeavouring to break the galleries. If this can be done, the miners proceed with their work ; but in case the guns have not reached them, the best way then is, to make some small Mines at the right and left of the hole, which when sprung, will not fail of destroying the enemies galleries, and then the miners prepare their Mines for making Breach.

The miners relieve one another every two hours, to carry on their work with more speed, which the Besieged, on their side, will endeavour to obstruct,  
by

by repairing their galleries, and lying in wait for the Besiegers, either to destroy them, or spoil their work.

To prevent their design, and secure the miners, a party of 10 or 12 grenadiers are ordered to follow them, with four or five shells, some with fuses only, and others loaded, the rest of the grenadiers carry grenades; and so soon as the miners have worked their way into the Besieged's galleries, the grenadiers throw some of the loaded shells and grenades in them, and retire together with the miners. The effect of these shells and the smoak will, in all probability, prevent the enemies return for some time; on the contrary, the Besiegers return immediately and stop up the hole with sand bags, leaving a small opening to throw more grenades in, in case the enemy should return; which if they happen to do before the hole is stopped, the grenadiers throw in some shells with fuses only, the expectation of whose bursting, or dread of whose effects, will be sufficient to oblige the enemy to retire, whilst the Besiegers continue their work without interruption.

The miners ought to leave no means untried to discover the enemies galleries behind the wall, which sometimes are not easily to be come at, as well as to prevent their making any new ones, and to use the utmost precautions not to be surprized themselves, which the enemy will not fail to attempt, either to destroy them or their works. The business of a miner requires great skill and conduct to avoid the stratagems of his enemies; he should listen frequently to discover whether the enemies are at work under or near him, and sound now and then with his iron needle, or Augre, not only  
towards

towards the place from whence he imagines any noise proceeds, but likewise all round him, taking particular care that the enemies, whilst they make a noise one way on purpose to draw his attention there, do not fall upon him and surprize him by another, which is a common stratagem amongst miners.

If the Besiegers perceive that their enemies are coming toward them, a small Mine must be made, to stifle them in their gallery, which may be done thus.

A hole of five or six inches diameter, and six or seven deep, is made on that side of the gallery where the enemy is expected, and some Powder made in a cartridge of the same size is put into it, which will contain about ten or twelve pounds; upon this powder is put a tampion, having a small quick match running through it, to give fire to the powder, and this tampion is covered with strong planks well buttressed; then as soon as the enemies are judged to be within four or five feet distance, this powder is fired, which will burst their gallery, and either kill the miners, or the smoak will oblige them to retire.

Another way of bursting the enemies gallery is, by placing several shells in such a manner as to have their effect that way. When the miners are in search of each other, they pierce the interval betwixt them, in several places, with the iron needle, to find as near as they can their distance: The miner must watch for this opportunity, and so soon as the needle is withdrawn, clap a pistol into the hole, which when well directed, seldom fails to kill the founder; the first shot may be followed by three or four more, and then the hole being cleaned,  
and

and care taken that the enemies do not stop it on their side, a hollow cane filled with a stinking composition is introduced, and stopped on the inside, which being fired, will make such a stink as will force the enemy to quit their galleries.

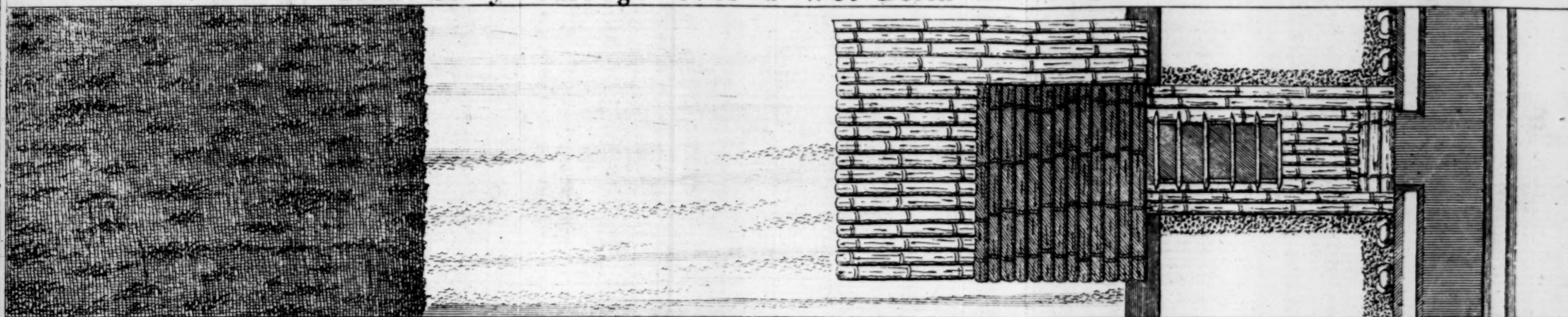
These and many other stratagems are used by skilful miners, not to be over-reached or surprized, whilst the enemy are at the side or above them; but when they happen to be undermost, it is difficult to prevent being served in the same manner.

#### RECAPITULATION.

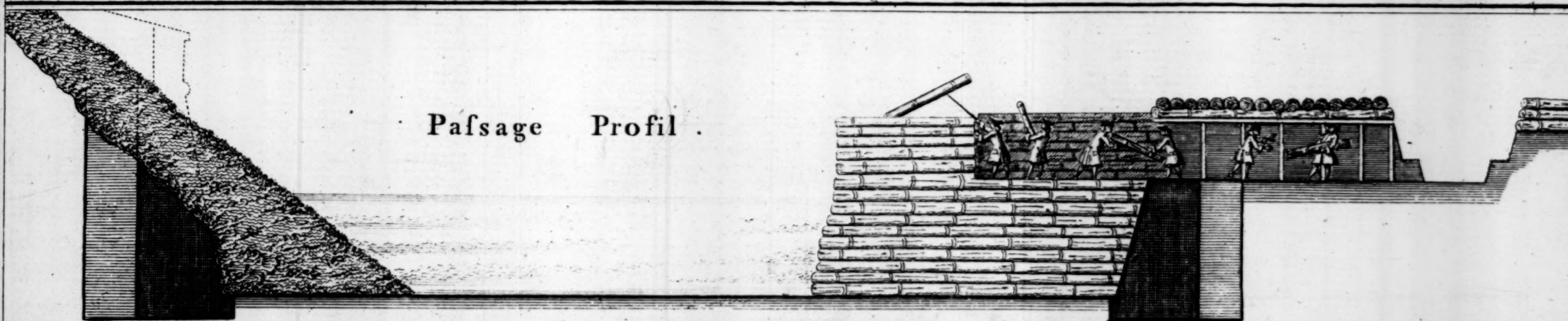
**W**HAT has been said with regard to the Attac of a regular Place fortified with ravelins and a covert-way, may, with proper caution, be applied to the Attac of any other Place likewise, whether regular or not, and fortified with any kind of out-works, observing for general maxims, *viz.* That the Approaches should ever be so directed, as neither to be enfiladed by any work of the Fortification, nor yet to defile too much, which would occasion more work than need; not to proceed uncovered after the fire of the Besieged begins to be dangerous, but to carry on the works by saps; the first Parallel to be always within 300 fathoms or less of the saliant angles of the covert-way, if it may be done: the second at 140, or thereabouts, from the first and the third, near or on the glacis; to make places of Arms, between the second and third Parallels, at the turnings of the Approaches, that the troops placed there may be at hand to support the workmen at the head of the Trenches, till such time as the third Parallel is finished; the miners to sink shafts in or near the third Parallel, and carry  
on



Plan of y Passage over a Wet Ditch .

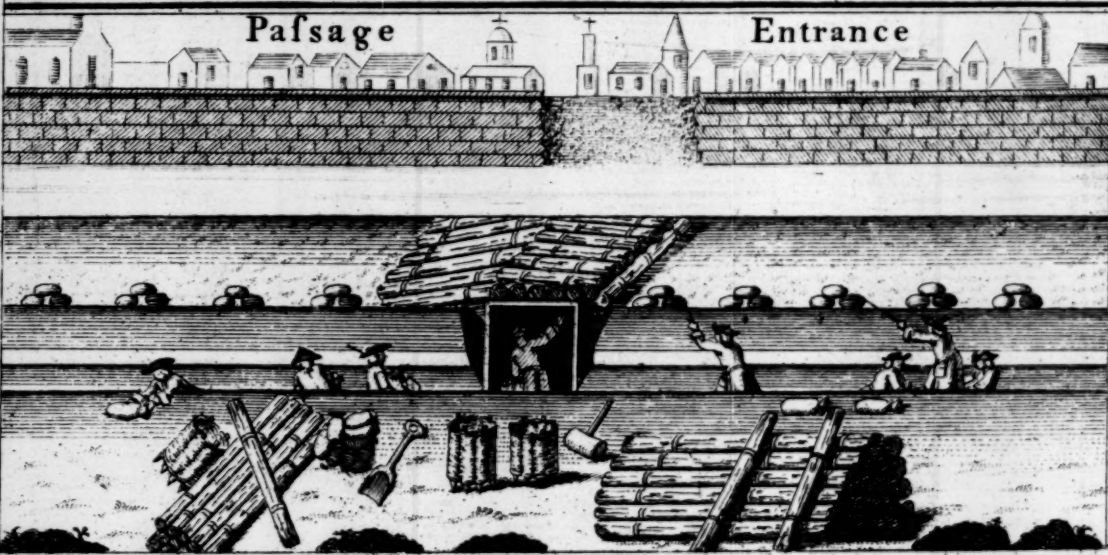


Pafsage Profil .

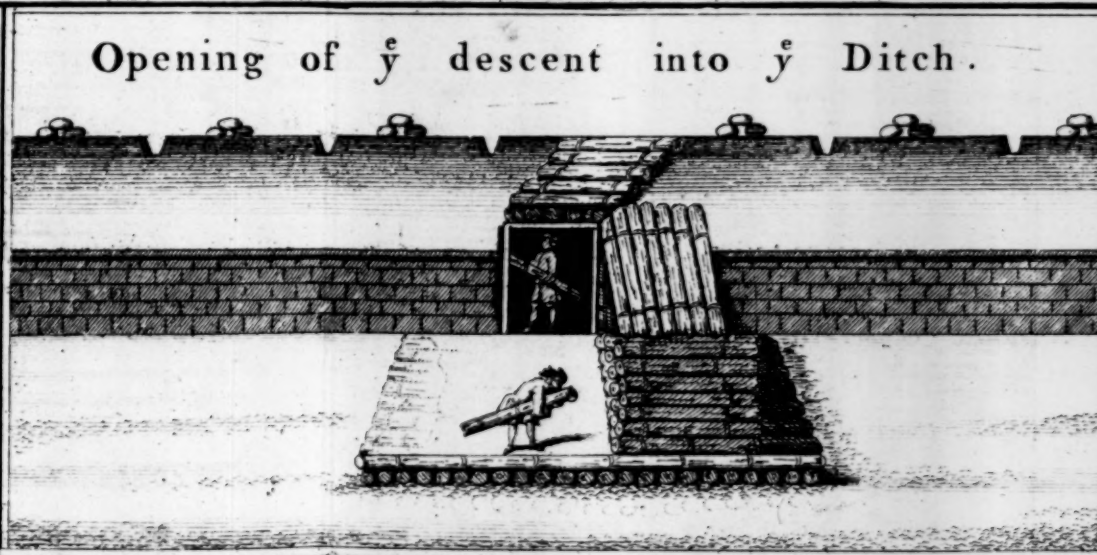


Pafsage

Entrance



Opening of y descent into y Ditch .



on their galleries under the works above ground, and in the same directions, endeavouring to get under those of the Besieged, if possible, to prevent being blown up by them, and, at the same time, have an opportunity of blowing up theirs, whenever it shall be thought proper.

The first Batteries are placed between the first and second Parallels, perpendicular to the faces produced of the works, and their number is always equal to that of the faces which flank the front attacked; from the third Parallel, double saps are to be made and carried directly over the ridges of the glacis, before the salient angles of the covert-way; within 12 or 13 fathoms of these angles, cavaliers are made, nearly perpendicular to the opposite branches of the covert-way; saps are carried along the glacis towards the retring angles, within three fathoms of the covert-way; which saps must be well traversed to prevent the enfilades; and lastly, Batteries are erected upon the ridge of the glacis, both to make breach, and to ruin the defences.

The fire from the cavaliers and *Ricochet* Batteries, both of guns and howitzes, and those for throwing stones and shells, will together, in all probability, drive the Besieged out of the covert-way, if not, they must be driven out sword in hand: The Besiegers being in possession of the covert-way, Batteries are made in the gorges of the places of Arms to batter the opposite faces, curtains and tenailles, if there are any; two or three descents are made into the same ditch near one another; the passage over the ditch, the Breach and lodgment in it, are made according to the manner described before.

These general maxims being well understood, a moderate capacity, and a little experience, will be sufficient



sufficient to understand Attacs of almost any kind of places whatever ; but for a farther assistance I shall give several examples of places variously fortified and situated.

The foregoing method of attacking the ravelin first, and afterwards the bastions, has been generally followed, especially when the garrison is strong, and commanded by a skilful and resolute Governor ; but when this is not the case, both bastions, and the ravelin before them, may be attacked together when the ditch is dry ; for whilst the breaches are making, and the flanks ruined, abundance of shells must be thrown into the bastions, lower flanks, if there are any, and into the ravelin, to destroy the retrenchments in them ; and making the descents into the ditches, either by saps or small mines ; when this is done a general attac may be made, without losing any time, in making secure passages cross the ditches, in the following manner : at dawn, strong detachments of grenadiers, followed by others of voluntiers, mount the three breaches at once, these must be supported by other troops ; in the mean time a detachment of grenadiers enter by the gorge into the ravelin ; and if there are casematted flanks, they get between the embrasures, and sling some grenades into them, threatening the Besieged to give them no quarters if they fire. If there is a sally-port in the curtain between the bastions attacked, a party breaks it open by means of a petard or otherwise, to enter likewise that way. This general attac being well concerted, and carried on with resolution, will scarcely fail of success, because the Besieged are surpris'd, not thinking of being attacked before the passage cross the ditch is made in a regular manner.

The

The French carried Bergen-op-zoom by such an attac in the late war, the garrison not suspecting in the least to be in danger ; they did not even think that the breaches were practicable.

*The ATTAC of a Place fortified with a CROWN  
or HORNWORK.*

PL. XIII. **W**E shall suppose, that the Approaches from the beginning to the third Parallel have been made in the manner already described, as being the same in all kinds of Attacs whatever ; this plate represents that part only which is particular to a horn-work placed before a bastion. L, L, L, being the third Parallel ; a, a, a, oval traverses, between the third Parallel and the direct double saps i, i, i, and b, b, b, the cavaliers of the trenches ; c, c, Batteries before the places of Arms to throw stones ; d, d, Batteries to make Breaches in the faces of the horn-work ; e, e, Batteries for making a Breach in the ravelin ; f, f, Batteries in the places of Arms, to fire at the faces, curtain and tenaille of the horn-work ; g, g, Batteries for enfilading the covert-way before the branches of the horn-work, as likewise to fire at the faces of the opposite ravelins ; k a lodgment in the Breach of the ravelin ; l, l, lodgments in the Breaches of the faces of the horn-work.

The Trenches within the horn-work, have nothing particular from those made in a ravelin ; it may only be observed, that from the lodgments l, l, in the half bastions, saps are carried on towards the curtain, and about half way, branches to the orillons to drive the Besieged out of the tenailles ; the first saps are continued quite round the curtain,  
before



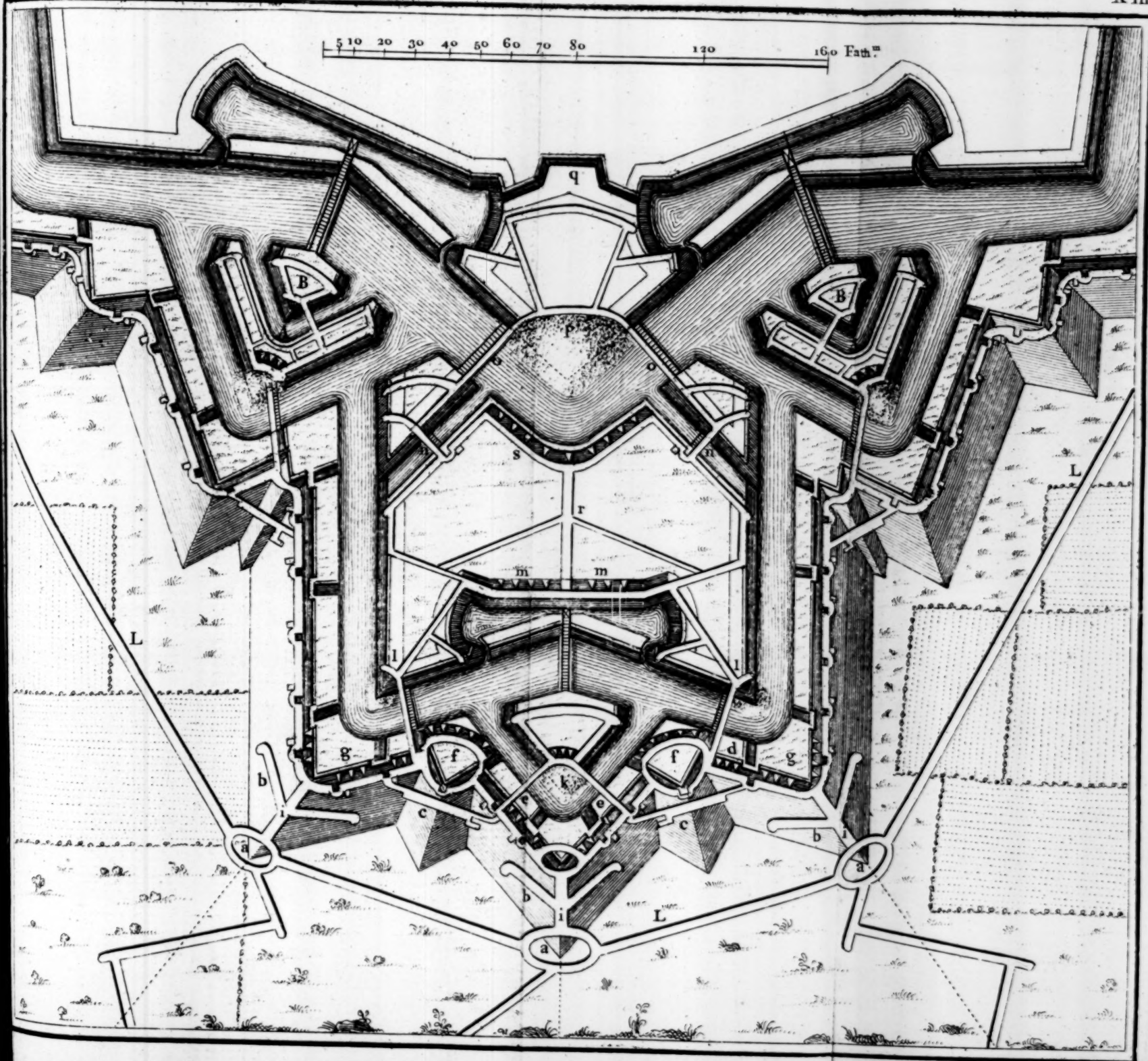
before which a Battery m, m, is made, to fire upon the retrenchments within the horn-works, as likewise to annoy the fire of the bastion; from the middle of the curtain a direct double sap is carried on directly to the point of the bastion; and from the extremities of the Battery m, m, other saps towards the parapet of the branches, and continued along them as far as the ditches before the retrenchments; these last saps are also join'd to the direct one r, by two others cross the horn-work, so as that they may have a free communication with one another, and to place troops in the latter to support the workmen: Lastly, a Battery is made near the Counterscarp of the great ditch to ruin the flanks which defend the bastion P, and to make a Breach in that bastion; then lodgments are made in the retrenchments within the horn-work, which are continued along their parapets to the counterscarp of the great ditch.

All those saps which are seen or enfiladed from any part of the place, must be well traversed, and made sufficiently deep, so as to be secure against the fire of the Besieged.

The horn-work being taken, the two adjacent ravelins A, A, together with their redouts B, B, must be taken, before the passage over the ditch round the bastion can be attempted, since these passages are seen from the said ravelins: As to the rest, the descent and passage over the ditch, the Breach in the bastion, and the lodgments in it, are all performed in the same manner, and with the same precautions, as described before.

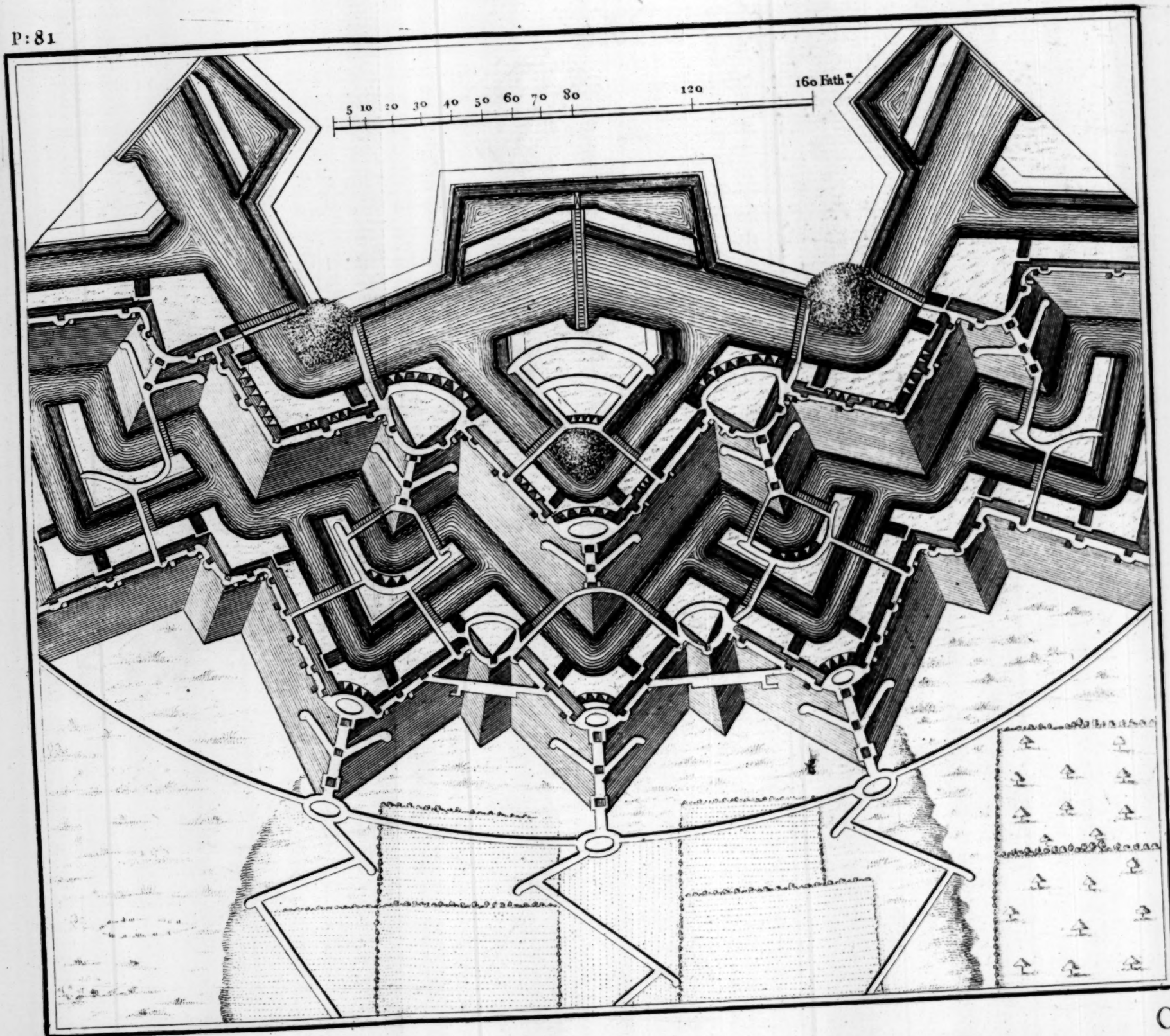
As there is no material difference between the attac of the horn-work and that of a crown-work; and whether these works are placed before a bastion







P:81



tion or curtain, the reader who understands the one will understand the other; so I shall insist no farther on it: It may be observed, that a horn or crown-work placed before a bastion, adds more strength to the place than when placed before the curtain; in the first case, the two adjacent ravelins A, A, must be taken; and when the crown or horn-work is taken, there can but one bastion be attacked, whereby the Besieged are enabled to unite their whole strength and defend it; whereas in the other, there is no occasion to take any more than one ravelin, and two bastions may be attacked together; by which the Besieged will be obliged to divide their force, and consequently are less able to resist the Besiegers.

*The ATTAC of a Place fortified with a second  
COVERT-WAY.*

THE Approaches from the beginning so far as to the third Parallel, are carried on in the manner already described; PL XIV. the second covert-way is attacked in the same manner, and with the same precautions, as the former in Plate X. The lunets are likewise attacked as the ravelins, and with the same precautions; Batteries are raised in them to fire into the first covert-way, and when the Trenches are carried round their gorges, the several passages over the second ditch are all made at the same time; but as the grazing fire from the first covert-way is very dangerous, great care must be taken to make the saps very deep, and to traverse them well; as likewise to enfilade the covert-way with the ricochet-Batteries, and to  
G throw



throw a great quantity of stones and shells into it at the same time, to diminish the enemy's fire as much as possible; without which, it would be impossible to make any lodgments on the first glacis.

This done, lodgments are made before all the saliant angles of the covert-way, and from thence saps are carried on directly over the ridges before these angles; about the midway, places of Arms or cavaliers are made at the right and left of these saps, as being absolutely necessary both for protecting the works and to plunge into the covert-way, to abate its fire: At the saliant angles before the ravelin, an oval traverse is made, so that the passage round it may take in the best part of that angle, and a Battery is made there, to annoy the enemy in the ravelin by an oblique fire; then the next traverses must be taken, and the sap carried on, on both sides, along the glacis, as already described.

It is not to be expected, that these works can be made without great danger and blood-shed; for the Besieged may sally out when they please with all their forces, and fall suddenly on the workmen and their guards, drive them from their work, destroy them, and then retire with safety; whereas the Besiegers can only oppose those in the places of Arms or cavaliers; and as the latter cannot be so well sustained by those placed in the second covert-way, on account of their great distance, and the intervention of the second ditch, as to be in a condition to make head against them, the Besieged have it in their power to do great mischief. To prevent this so far as possible, the gun and mortar Batteries placed on the second glacis, and in the lunets, must continually play into the covert-way,

as aforeſaid, to enfilade it, and plough the ridge of the glacis in ſuch a manner as that the Beſieged dare not ſhew themſelves; which, in time, will drive them quite out, and oblige them to retire into the places of Arms.

The lodgments on the glacis being advanced to the places of Arms, if the Beſieged are obſtinate in their defence, they muſt then be driven out by a detachment of grenadiers, ſword in hand, and lodgments made in them; as likewise Batteries in their gorges. This, and the Attacks of the ravelin and baſtions are made in the manner already explained.

The writers on fortification ſeem not to have properly conſider'd theſe kind of outworks; ſo little notice has been taken of them, as would make one believe that they are but of little ſtrength; but conſidering the many Batteries neceſſarily to be raiſed, all the ſeveral paſſages over the ſecond ditch, the number of lodgments to be made, with the great difficulty in maintaining them, on account of the defence theſe works mutually afford each other; I ſay, all theſe well conſider'd, are ſufficient proofs of their excellency.

Mr. Goulon, tho' a great Engineer, as appears by his excellent memoirs on the Attack and Defence, ſeems not to have been ſufficiently apprized of the advantages of theſe works; he conſiders indeed the ſecond ditch as dry, which very rarely happens, and when they are ſo, they are made in ſuch a manner as to afford no ſhelter to the Beſiegers, as he imagines.

On the contrary, this ditch is not only wet, but has generally fluices, which will make the water riſe up half way the firſt glacis; and in that caſe, how will

the Besiegers make their trenches, to bring the earth from the second glacis, requires much time and trouble, and many gabions and fascines; I see no other remedy than to break these sluices with shells, and as they are secured with arches and cover'd with earth, a thirteen inch shell will have no effect upon them; for which reason the French have generally one or two eighteen inch mortars which they use upon such occasions, as they did at Aeth, where they fired three days before they could break the sluice that kept up the water in the great ditch.

*The ATTAC of a Place fortified with DETACHED REDOUTS.*

**D**ETACHED Redouts, when they are well made, should be within musket-shot of the covert-way, that is, within about 50 fathoms of it, that their communication may be well defended. But it happens sometimes, that they are made much farther, to occupy a spot of ground which may otherwise be advantagious to the Besiegers; in which case, the Approaches are carried round so as to take them by the gorge, whilst the mortar Batteries throw shells and stones in them; which will oblige the defenders either to retire betimes, or run the risk of being made Prisoners of War.

If the Redouts happen to be arched, as at *Luxembourg*, or their communications with the Place are under-ground, as at *Maastricht*: In the first case, the stones and shells have very little effect, if the shells happen not to break them; the best way then is, to make Mines under them and blow them up: And in the second, they may either be taken by carrying the Trenches round them, or  
blow

blow them up likewise: The advantage of these latter kind is, that they may be defended to the last extremity, without exposing the garrison to be made prisoners, as in the others.

When they are within about fifty fathoms of the covert-way, a Breach must be made, and whilst they are attacked, and lodgments made in them, the Batteries must fire smartly on all the parts of the covert-way, which defend them: But when the Redouts are quite close to the glacis, they must be attacked at the same time as the covert-way; for if they are attacked before, the Besieged will always be in a condition, on account of their nearness, to drive the Besiegers out of them.

The Besieged may make great use of Mines in the defence of such works, whereby their Attacks would become very troublesome; the only remedy in this case is, to make Mines also, and to get under the gallery of the Besieged, if possible, or else it must be endeavoured to find them out, and either destroy their Mines, or render them useless.

If there are any Arrows at the salient angles of the glacis they must be enfiladed by the ricochet-Batteries, and great quantities of shells and stones thrown in them, to oblige the defenders to retire.

ATTAC *of a Place fortified with* LUNETTS, TENAILLONS, *or* COUNTER-GUARDS.

**A**PPROACHES, so far as the covert-way, being made as before described, the faces and branches of both tenaillons must be enfiladed by the ricochet-Batteries, as likewise the faces of the ravelin, if it can be done; then a Breach is made in each Tenaillon at the same time, and both at-



tacked together, whilst all the Artillery that can reach any part of their defence play continually upon them, as likewise the ricochet-Batteries, must endeavour to enfilade them every where: but if the Besieged have made any traverses to prevent the effect of the Ricochets, nothing but a great number of shells and showers of stones will be able to annoy the Besieged, and protect the Attacks, so as to enable the Besiegers to make their lodgments in the upper part of the Breaches.

As the ravelin cannot be attacked till such time the Tenaillons are taken, and the lodgments in them finished; the Batteries which the Besiegers are obliged to raise in the Tenaillons, to make a Breach in the ravelin, will be attended with great trouble and blood-shed, the ravelin defending these works wonderfully well on account of their nearness. The Besieged will hardly give the Tenaillons up after the first taking them; but on the contrary, will return and drive out the Besiegers in their turn, and hold them thus in play so long as they remain masters of the ravelin, as it happened at *Lisle* in 1708, where the *French* drove the Allies out three several times. The condition of the Besiegers will still be worse, if there are retrenchments in the Tenaillons, as there commonly are; for which no other remedy can be found, than to pour in such quantities of shells and stones, that the Besieged may have more need to shelter themselves, than to think of obstructing the Besiegers in their work; and after the Tenaillons are taken, the retrenchments must likewise be taken, before the Besiegers can be secure in the possession of these works, and to be able to attac the ravelin.

If the ravelin has lunets adjoining to it, but no bonnet before its saliant angle, a Breach may then be made in the faces of the ravelin at the same time as those in the faces of both lunets, that all three may be attacked together : but if there is a bonnet to cover the saliant angle of the ravelin, it must be taken first ; and when the lodgments in it are finish'd, Batteries are to be erected to make a Breach in the ravelins : but as this bonnet is well defended both by the lunets and ravelin, the maintaining these lodgments will meet with some difficulties till the rest of the works are all taken : in the mean time the ricochet-Batteries must scower the lunets and ravelin, as also great quantities of shells and stones are to be thrown in them, to abate their fire as much as possible.

These kind of works are capable of great Defence, as being so near each other, that the enemy may sally out of the ravelin whenever they please, fall on the workmen in the lunets or tenail-lons, drive them out, destroy their work, and then retire with safety ; and this may be done so long as the ravelin is in their possession : for which reason, they have always been esteemed by the greatest Engineers amongst the best works that can be made, when the expence and nature of the ground will permit.

When a ravelin is covered by a Counter-guard, a Breach is made in the latter much in the same manner as in a ravelin ; and, whilst the Assault is making, a great quantity of shells and stones must be thrown into the ravelin, and the ricochet-Batteries try to enfilade its faces, endeavouring to drive the Besieged from their defences, and to diminish their

fire ; otherwise the taking the Counter-guard would be attended with great difficulties.

A lodgment being made in the Breach, saps are carried on along the parapets on both sides towards the gorge, and Batteries erected to make a Breach in both faces of the ravelin ; which, when made, as also the passage over the ditch, the ravelin is assaulted and taken in the manner described.

If there are Counter-guards before the bastions, they are to be attacked at the same time as the ravelin ; the narrowness of their rampart, and the vicinity of the bastions, renders the making the lodgments in them very troublesome ; and as they are enfiladed by the opposite flanks, they must be made very deep and well traversed ; whilst they are making, shells must be thrown into the flanks to abate their fire, otherwise there is no going on with the work. As these Counter-guards cover the flanks in such a manner as not to be seen from the covert-way, they cannot be destroyed from any other place than from within them ; and if they are double, and the Counter-guards narrow, the Batteries made in them will not be sufficient to destroy the flanks ; and therefore others must be made besides these in the gorge of the ravelin, to batter them obliquely ; but if the ravelin should have a redout in it, it will be hard to find room enough for those Batteries.

What has been said in regard to the Attacks of Counter-guards placed before the Bastions, sufficiently shews their usefulness, especially when they are well made : but if their thickness is only twenty eight feet, as Mr. *Blondel*, and after him Mr. *Coeborn* will have it, there is not, they say, a sufficient space within them to erect Batteries for destroying the flanks ;

flanks; whence the Besiegers will be obliged to bring earth from the covert-way to fill up a part of the ditch, so as to enable them to place a sufficient number of guns for ruining them; which must consequently take up much time, and require great labour. But these Gentlemen did not consider, that three or four small Mines placed under these kind of Counter-guards will blow up so much of them as to make an opening wide enough to batter the flanks from the opposite covert-way; whereas, if instead of twenty eight feet they are made about eight or nine fathoms broad, there will not even then be room enough to place a sufficient number of guns in them to destroy the flanks, and yet they will be secure from being blown up by Mines.

When the Counter-guards are nearly as high as the bastions, and have retrenchments lined with stones or bricks, with a ditch before them, it is certain, that no kind of works whatever are able to make so great a defence as they. The Breach being defended by the faces of the bastions and the retrenchments, neither of which can be destroyed before by cannon, makes it hardly possible to get possession of it and secure a lodgment. All that can be done is endeavouring to destroy the retrenchments by shells, during the assault, to sling a great number of shells into the bastions, flanks, and great showers of stones into the retrenchments, to annoy the Besieged so much as possible. A lodgment being secured, Batteries must be erected both to make a Breach in the bastions and destroy the flanks; which cannot be accomplished but with great labour and difficulty; and if the Besieged have mines to blow up these Batteries, they must be

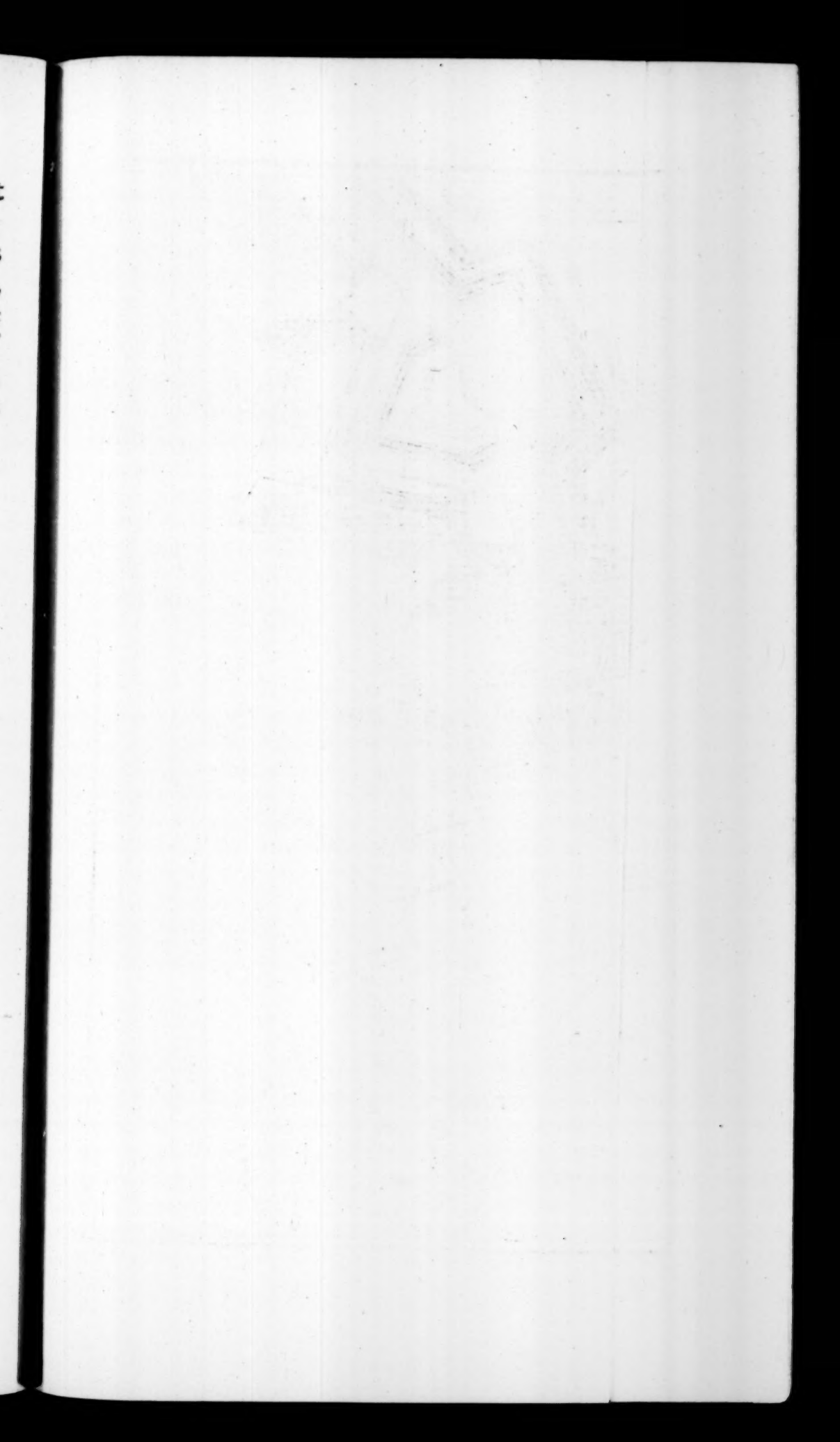


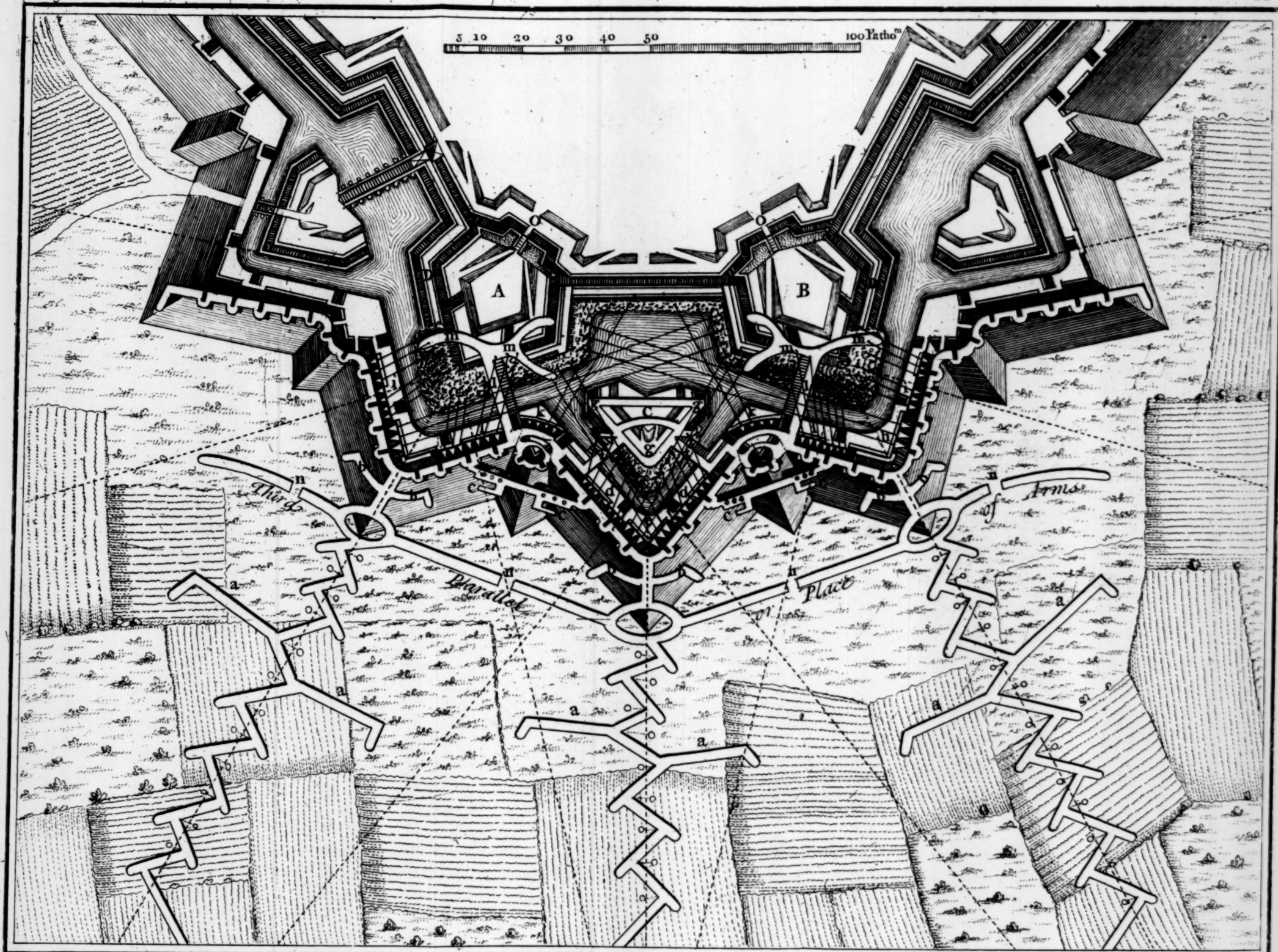
be searched after and rendered useleſs, otherwiſe it would be impoſſible to maſter the place.

The French are ſo ſenſible that Counter-guards before the baſtions, are preferable to all other works, that they have built ſome before the baſtions of the citadel of *Liſle*, with retrenchments in them, tho' it had a double ditch and Covert-way: they did the ſame before the baſtions in the front that was attacked by the Allies in *Queen Anne's* war, notwithstanding that there are retrenched tenaillons before the ravelin.

*The A T T A C of a Place fortified with a F A U S S -  
B R A Y.*

**B**Y a Fauſs-bray is meant a ſecond parapet going quite round the baſtions and curtains, nearly on a level with the inſide of the covert-way, and about four or five fathoms diſtant from the upper parapet. The interval between theſe parapets is a dry ditch, ſerving as a rampart to the Fauſs-bray; the Citadel of *Tournay*, and a few other Places are fortify'd after this manner: Mr. *Coeborn*, tho' he made uſe of them in his Treatiſe on Fortification, making the dry ditch from ſixteen to twenty fathoms broad, yet he never apply'd them, in any Place he has ſince fortify'd. Theſe Fauſs-brays being low, produce a grazing fire, which adds much to the ſtrength of the Place; but ſince *Vauban's* Invention of Ricochet-firing, theſe low works are of very little uſe, there being nothing eaſier than to enfilade them from one end to the other; and as they are very narrow within, the ſhells and ſtones make a terrible havock amongſt the troops placed there; and if the upper rampart  
has







has a revetement, and that being fired upon, the rubbish which falls from thence will hardly permit the Besieged to keep their posts, much less to defend them.

The Besieged being driven out of the Faufs-bray by the shells, stones, and Ricochets, the passage over the ditch is made, as also the Breach in both parapets, the Rubbish of which will serve to fill up the dry ditch or space between the parapets; if not, an epaulment must be made from one Breach to the other, at the side next to the Place; as likewise a lodgment may be made there to prevent the Besieged from coming that way, and to support the lodgment which is made afterwards in the upper Breach: as to the rest of the works, they are made and carried on as usual.

*Explanation of* P L A T E XV.

- A, B, Bastions of the front of the attac.
- C. Ravelin before that front.
- D. Faufs-bray.
- b. Cavaliers of the Trenches.
- c. Stone-batteries.
- d. Batteries to make breach into the ravelin C.
- e. Batteries against the defence of that work.
- f. Passage over the ditch of the ravelin.
- g. Lodgments in it.
- h. Batteries against the defence of the Bastions A, B, and that of their Faufs-bray.
- i. Batteries to make Breach into these Bastions.
- k. Batteries against the curtain.
- l. Passages over the ditches before the Bastions.
- m. Lodgments in the bastions and Faufs-brays.
- n. Passages made of fascines to carry the guns over the Parallel to their Batteries.

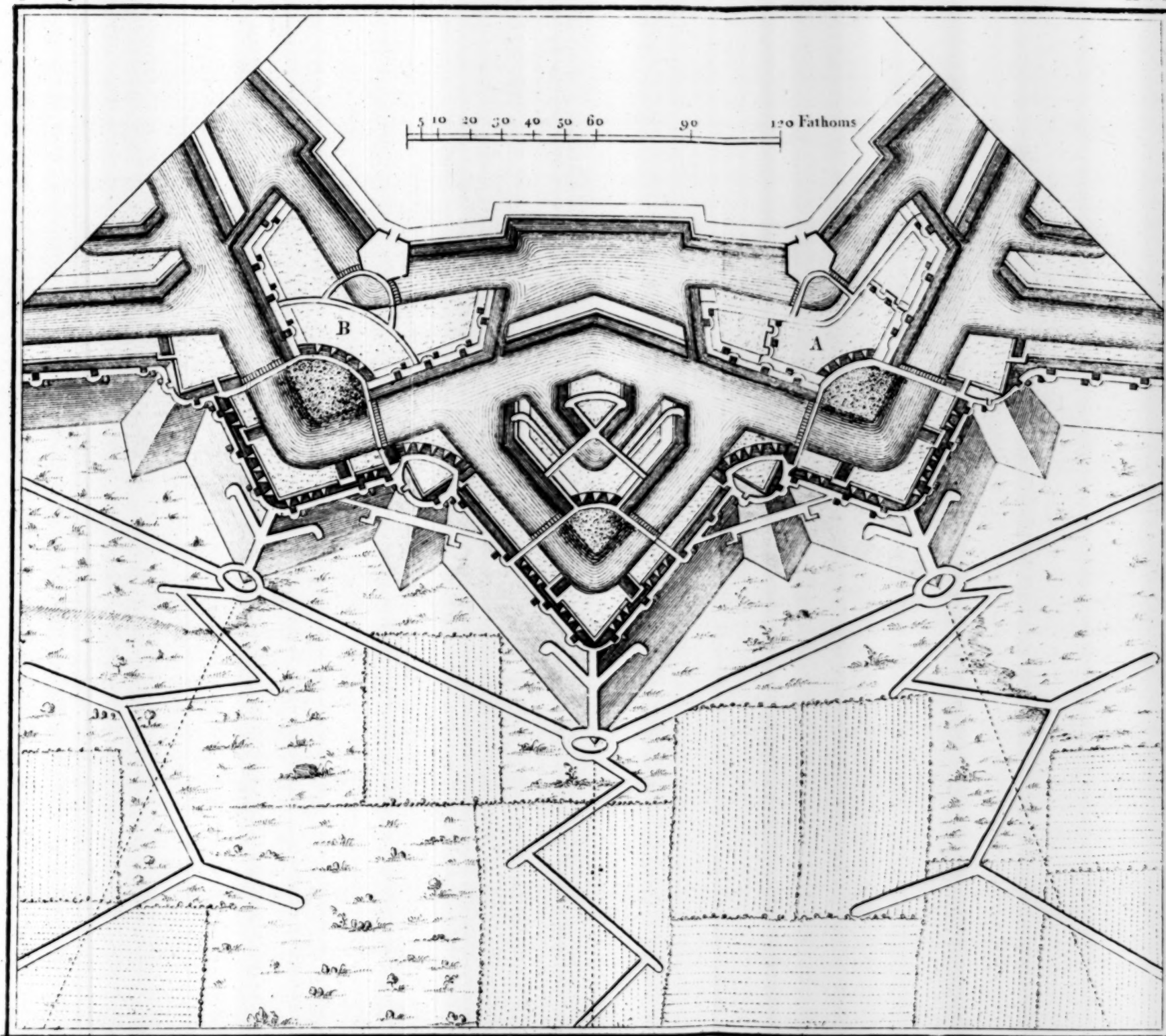


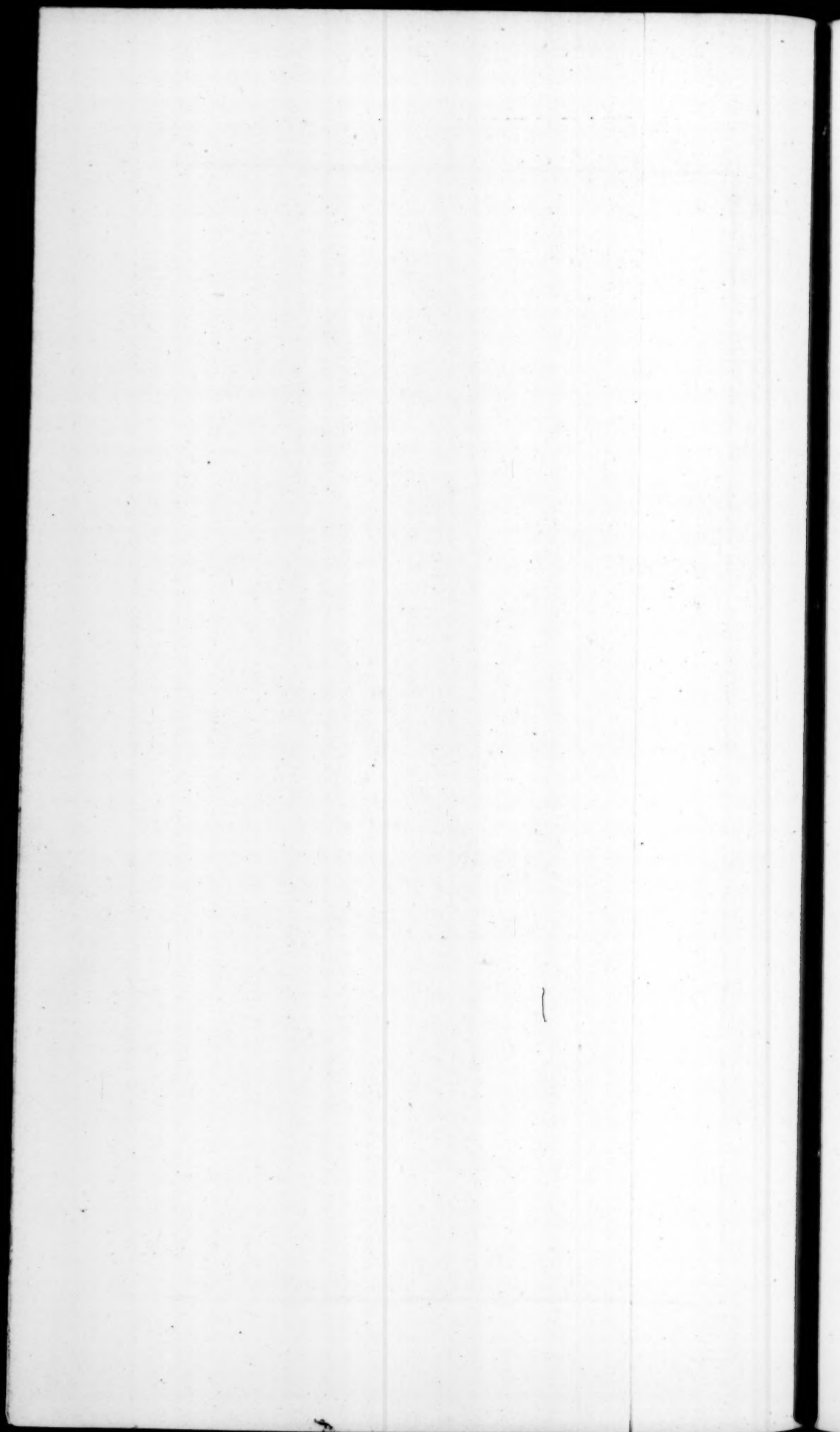
*The ATTAC of a Place fortified with TOWER-BASTIONS.*

PL. XVI. **T**HE Trenches before such a Place so far as the taking the covert-way, are in no respect different from those of other Places: The counter-guards being nothing else but detached bastions, they should therefore be attacked in the same manner; but as they are separated from the body of the place, they may be defended to the last extremity, without exposing the Town to the hazard of being taken by storm, and consequently, they must be attacked with great caution; their defence must be thoroughly ruined, shells and stones thrown into them without intermission, and their faces and flanks enfiladed by the ricochet-Batteries.

The Breach being made, and the lodgment in it finished, a Battery is made at the saliant-angle, to batter the Tower-bastion, and in the mean time saps are carried on along the parapets of the faces and flanks; from these lodgments near the flanks, the Besieged are driven out of the tenailles, if they have not abandoned them before, and from the extremities of the flanks saps are carried on, on both sides along the gorge, so as to meet before the point of the Tower. These saps are joined afterwards to those near the faces, by direct saps, so as to be able to support one another, as may be seen in the counter-guard A; or the saps near the faces may be joined by a kind of a round Parallel approaching the ditch before the point of the Tower-bastion, without making any sap along the gorge, as in the counter-guard B.

As





As the lodgment in the counter-guards are exposed to the fire of the Tower-bastions, and the ramparts adjoining to them, it will cost the Besiegers much time and numbers of Men, before they can erect Batteries to extinguish that fire, which, however, they will accomplish in time.

To come at the flanks of the Tower-bastions, the extremities of the flanks of the counter-guards which cover them, must be ruined by Batteries placed on the covert-way, which will not be easy to accomplish, as being about 24 feet in length, and the whole thickness of the parapet; after this the faces of the Towers must be battered to make Breach, at the same time the passage over the ditch is making.

When the passage is finished, and the Breach sufficiently wide, the Besiegers must endeavour to lodge themselves at the upper part of it; but as the Towers are casematted underneath, and these casemats divided into several apartments, the Besieged will be able to defend the Towers a great while; and till such time that the casemats are either stopped up or destroyed, it will hardly be possible for the Besiegers to lodge themselves in the Breach. Wherefore it will be necessary to make Batteries opposite to the faces, quite close to the ditch side, to batter the casemats; which being once destroyed, or stopped up, and the lodgments in the Breaches finished, the Besieged will hardly venture to hold out any longer.

Notwithstanding that the Tower-bastions may draw out the Siege to a considerable length, when they are defended as they ought to be, yet *Landau* was taken four times in the late wars, without attacking the Tower-bastions, the Place surrendering before-



before-hand; but whether this was owing to the imperfection of the works, the want of means to defend them, or the unskilfulness and timidity of the Commanders, is a question undecided.

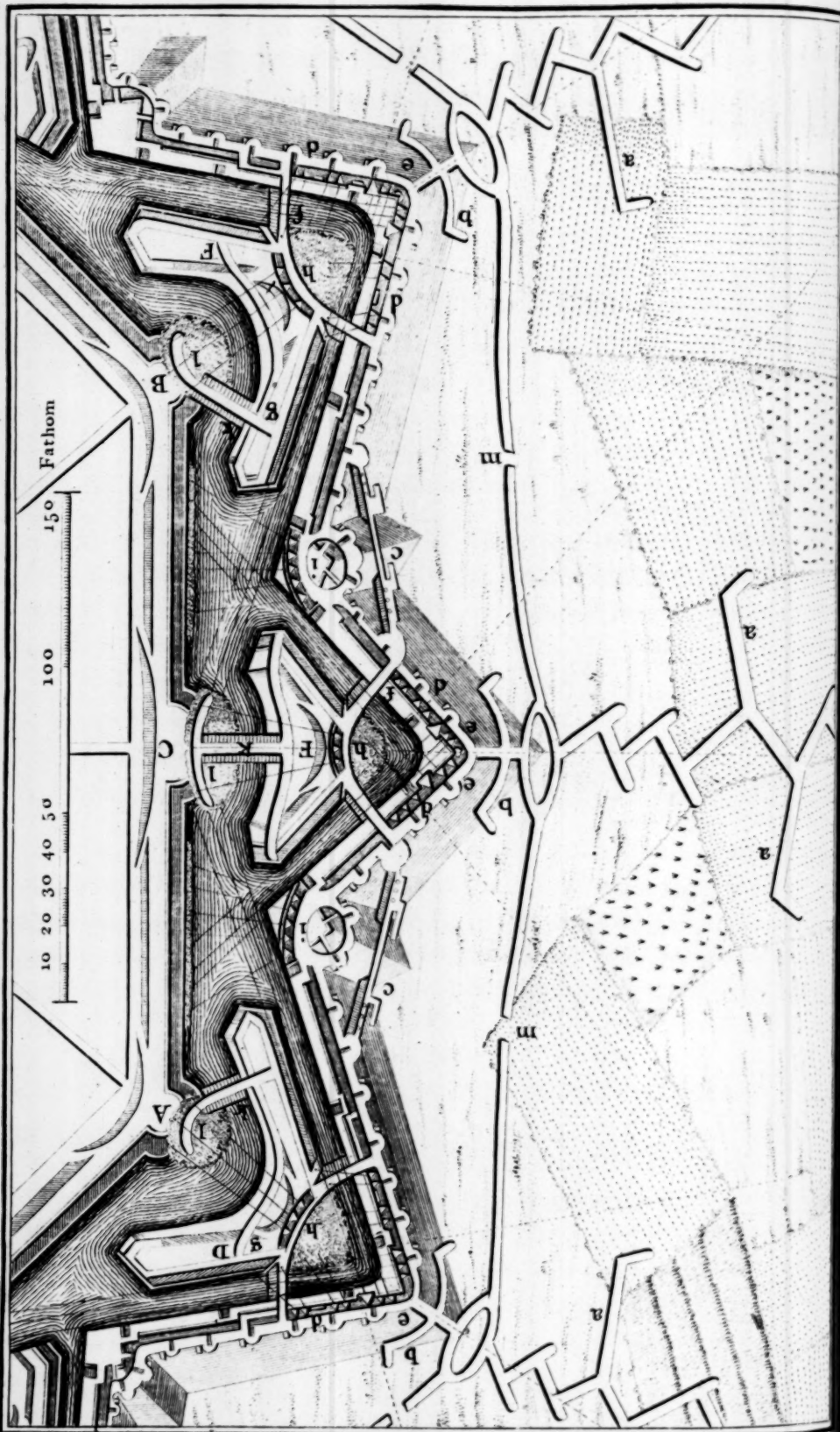
This method of attacking a Place fortified with Tower-bastions, is that which its inventor imagined would be pursued; but if instead of attacking the Tower-bastions themselves, the adjacent ramparts were attacked, it would, in my opinion, make the work much easier; for the flanks and faces of the Towers being well battered, to render the guns in the casemats useless, a Breach might be made in the rampart, without much difficulty; then all the great defence which *Vauban* proposed with these under-ground works can be no obstacle.

It is well known, that in a short time these casemats are so filled with smoak, that there is no staying in them, notwithstanding their chimneys, and as these Towers are made of solid masonry, they are quite rejected at present by the best Engineers, as not answering in the least the expence of building them.

*The ATTAC of a Place fortified with RAMPARTS without BASTIONS, according to the ancients, and covered with OUT-WORKS, in the modern manner.*

**W**HEN such Places are fortified with counter-guards and ravelins, as customary, they differ not much from a Place fortified with Tower-bastions; they generally have large wet ditches, filled with running water, as at *Douay*, *Tournay*, *Barcelona*, &c. The out-works of these Places are attacked in the same manner as usual; but as the wideness of the ditch renders their communication  
with





with the body of the Place inconvenient, and easily to be cut off, they cannot make all the resistance which they otherwise might, if their retreat was more secure; it is for this reason that the Besiegers erect Batteries in such places as have a view of the communications, which soon obliges the Besieged either to quit betimes their out-works entirely, or to leave but few men to defend them, who are generally made prisoners of War.

If the ditch before the body of the Place is full of running water, the passing it requires \* much time and trouble, on account of its largeness; two or three passages must be made, and as many Breaches, which the Besieged may defend for some time, especially when the garrison is pretty strong; but the superiority of the Besiegers both in men and Artillery, will get the advantage over the Besieged, let them be ever so obstinate, and therefore must at last submit.

PLATE XVII. *Explained.*

- A, B. Towers of the old rampart.
- D, E, F. out-works which cover those towers.
- a. Half Parallels, or places of Arms.
- b. Cavaliers of the Trenches.
- c. Stone Batteries.
- d. Batteries to make Breach in the pieces D, E, F.
- e. Batteries against the defences of these pieces.
- f. Passages over the ditches before them.
- g. Lodgments in them.

\* The Allies attacked *Douay* in the late Wars, near the gate of *Nôtre-Dame*, and tho' there were but few out-works, yet the Town made a vigorous Defence for six weeks. This Place has since been well fortified by the *French*.

h. Batteries



- h. Batteries to make Breach in the Towers A, B, C.
- i. Batteries against the curtains.
- k. Passages over the ditch before the Towers A, B, C.
- l. Lodgments in these Towers.
- m. Passages of fascines in the third Parallel to carry the guns over to their Batteries.

*ATTAC of a Place fortified with CAVALIERS.*

**T**HE Cavaliers are generally placed within the bastions, and made of the same form, leaving about 5 fathoms room between the parapets, serving as a rampart to the bastion, and their height exceeds that of the bastion by about six or seven feet; some times they are placed elsewhere, as in the gorges, or behind the curtain; but this happens but seldom.

Cavaliers are only made when the Town is commanded by some hill or rising ground within cannon-shot, as at *Aeth* and *St. Omer*; they oblige the Besiegers to open the trenches far off, and when the Approaches are advanced near the glacis, the Cavaliers plunge into them, which, on that account, must be made deeper than usual; Batteries are made to enfilade them, if possible, otherwise a great number of shells are thrown into them, endeavouring to dismount their guns; but as the throwing shells is pretty uncertain, and the Batteries of cannon can do them no great damage when they are near, and not able to reach them when far off, it seldom happens that all the guns can be dismounted, as it happened at *St. Omer* in Queen *Ann's* War, where two guns placed in a Cavalier could never be dismounted by the Allies, during the whole Siege; for which reason the Batteries of mortars must continually

tinually play upon them, to lessen, at least, their fire, if the guns cannot be dismounted.

When the miners get under the bastion, they must carry their galleries under the Cavaliers likewise, to make Breach in both at the same time; but if the Cavaliers are placed near the gorge of the bastion, as done by some Engineers, the bastion must be taken, and lodgments made in it, before the Cavalier can be attacked. If there is a ditch before the Cavalier, with a row of palissades in the middle, they must be destroyed with guns placed in the bastion, or else the miners must get under them to blow them up. As the inside of the bastion may possibly be full of mines, the Besiegers must act with great caution, so as not to be blown up at every step they advance: it will therefore be proper to carry galleries under the works above-ground, to secure themselves, especially when there is any suspicion of Counter-mines, which may be guess'd at by the proceedings of the Besieged, the capacity and resolution of the Governor, and strength of the Garrison.

If all the Places were situated on even ground, the general rules already given would afford sufficient directions for carrying their Attacks; but as most of them are surrounded either by rivers, brooks, or marshes, or are situated on hills or rising grounds, so as to be only accessible in some parts, the direction of the Trenches varies accordingly; and therefore chiefly depends on the skill and experience of the Engineers, who are to take such measures as are most suitable to their situations. All the different circumstances which they are attended with are impossible here to be particularized; for which reason I shall make some general observa-

tions, to give at least some idea of what ought chiefly to be attended to in the Attacs of Places variously situated.

*The ATTAC of a Place situated on uneven ground.*

**I**F the Place be surrounded with a morass or low ground, so as only to be approached by some causeway, the first thing to be done is, to try whether the marshes may not be drained, and the water turned into some other channel, which may sometimes happen; but if that is not to be done, the Trenches must be carried along the causeway, widening them as much as possible, and making Batteries in the most convenient places, such as are to be found, or may be made for that purpose; and as the ground will scarcely allow of making Parallels, or places of Arms, half Parallels, must be made at proper distances, to protect the workmen in the best manner that the nature of the ground will admit.

If the causeways happen to be so little above the level of the water as not to furnish a sufficient quantity of earth for making the Approaches, they must be made with gabions, fascines and sand-bags; and sometimes the Trenches are made wider than ordinary, to furnish a sufficient quantity of earth for raising their parapets. It must be observed particularly, whether the causeways are enfiladed wholly, or in part only, by the works of the Place; if they are every where enfiladed, and there is no opportunity of turning the Approaches, so as to avoid the greatest part of the inconveniency, the Attac will, in such cases, be next to impossible; and if there are no places to be found for erecting Batteries,

ries, to annoy and enfilade the works of the Place, the condition of the Besiegers will still be worse.

If, notwithstanding all these obstacles, the Siege of such a Place be resolved upon, then the foundations where they are bad, must be mended with fascines or hurdles, covered with some earth brought from some other place, and the parapets made with gabions and sand-bags, and the work carried on in a direct double sap frequently traversed. The reader will imagine that a work of this nature is not to be carried on a great way; we suppose that there is not above 50 or 60 fathoms at most that requires it.

It is in a situation like this, that an Engineer may display his ability, since there can hardly be a more difficult one to be found; but should all his endeavours prove vain and fruitless, the best and only way left is to reduce such a Place by famine, as being easily blocked up by a small number of troops, they can seldom hold out long, on account of their unhealthy situation, and oft are short of provision.

But if the causeways are six or seven fathoms broad, and five or six feet above the level of the water, and if any places are besides to be found, or may be made with little trouble, for erecting Batteries, so as to enfilade the works of the Place; such an Attac may be made, tho' not quite so conveniently as if it were situated in an even country.

Amongst the difficulties to be encountered in attacking a Place so situated, there is this advantage, that as the country must be unwholesome, the garrison is commonly sickly, and not in a condition to undergo the fatigues of a long Siege; besides, few Places are so entirely surrounded with marshes,



but that some part or other about them may be proper for making Approaches; it is indeed certain, that those parts, which are easiest of access, are always better fortified than the rest, however it is best to make the Attacs on that side; for the advantages of the ground will be more than equivalent to the additional strength of the Fortification. But it will not be improper to try whether the marshes are not to be passed over by some means or other. If on the one side the difficulty of passing be compared with the surplus of the strength of the works on the other, one may form a judgment, which of the two Attacs will be easiest.

When the *French* besieged *Philipsbourg* in 1734, had they known that the marshes extended only about 50 yards, as they found afterwards, when the Town had surrendered, they might have been much sooner masters of the Place, and would have saved great expence and many lives; which evidently shews the importance of thoroughly examining the ground about the Place, before the Attac is resolved upon; for every thing tho' trivial in appearance may contribute to advance or retard a Siege considerably.

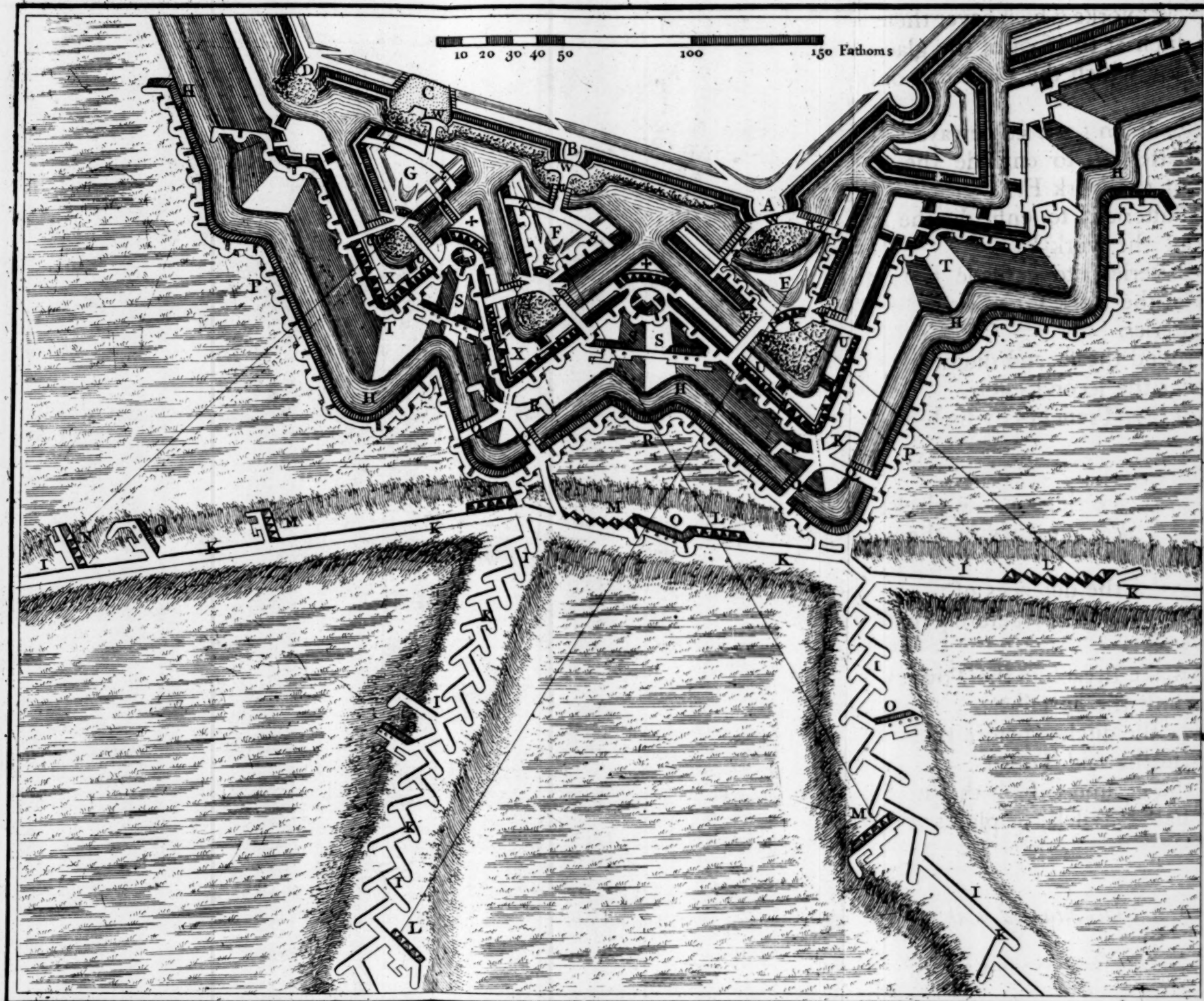
At the said Siege of *Douay*, General *Armstrong* finding that a causeway kept up the inundation which the *French* had made on the side near the Attac, proposed to the Duke of *Marlborough* the draining of the water, by means of a trench a-crofs this causeway; which being done, he succeeded to his wishes, for it greatly helped to forward the taking of the Place.

*Explanation of PLATE XVIII.*

A, B, C, D. Towers, which flank and form the front attacked.

E, F, G.







- E, F, G. The out-works which cover these Towers.  
 H. A second ditch at the foot of the glacis.  
 I. Causeways, by which the Place can only be approached.  
 K. Trenches made on these causeways.  
 L. Ricochet-Batteries, to enfilade the faces and covert-way of the work E.  
 M. Ricochet-Batteries, to enfilade the faces and covert-way of the work F.  
 N. Ricochet-Batteries, to enfilade the faces and covert-way of the work G.  
 O. Mortar Batteries.  
 P. Trenches round the second ditch.  
 Q. Passages over the second ditch.  
 R. Cavaliers of the Trenches, which enfilade the covert-way.  
 S. Stone Batteries.  
 T. Trenches upon the ridge of the glacis.  
 U. Batteries to make Breaches in the works E, F, G.  
 X. Batteries against the defences of  
 Y. Passages over the ditches before } these works.  
 Z. Lodgments in  
 a. Batteries to make Breach in the Towers A, B, C.  
 b. Batteries against the curtains.  
 c. Passages over the ditches before these Towers.  
 d. Lodgments in the said Towers.

N. B. As the ground is such that no sallies can be made, the half Parallels, or places of Arms, are omitted here.

*The ATTAC of a Place situated near a great river.*

PLACES near rivers are not so difficult of access as those surrounded by marshes; their Approaches



proaches are made as usual, on the side most convenient; which generally is that next the river, if it is large, and does not run through the Town; but, on the contrary, when it does, the Attac is then made on the farthest side from the river, as before mentioned.

If the Attac is made on the river side, Batteries are raised on the opposite shore, to ruin the defences of the works which are seen from thence; as also to enfilade, and even to make sometimes a Breach from that side. *Vauban*, at the Siege of old *Brisac* in 1703, made a Battery in an Island formed by the *Rhine* to batter the works attacked, and to make Breach, by which the Siege was much accelerated; and at the Siege of *Fort Keil*, in 1733, Batteries were erected in an Island, which made Breach in the horn-work attacked, as likewise in the bastion behind the horn-work; the same Batteries enfiladed besides the covert-way, before that bastion that defended the branch of the horn-work next the *Rhine*.

At the above-mentioned Siege of *Philipsbourg*, the *French* took Fort *St. Michael* on the other side the *Rhine*, and erected Batteries there, which enfiladed the defences of the front attacked, and thereby prevented the fire of the Besieged from much disturbing their Trenches.

When there is a bridge over the river, it is generally covered by some Fort, as at *Hunninghen*, *Philipsbourg*, &c. in that case Batteries are placed near the river, so as to destroy that bridge before the Fort is attacked; which being effected, the Fort will soon be obliged to surrender, or else the garrison will be made prisoners of war.

It is an observation of importance, to know at what time the river overflows, and the extent of its inundation, to secure the Trenches from being overflowed, as likewise to place the Batteries and the park of Artillery so as not to be incommoded thereby. It often happens that rivers become fordable along the shore in dry weather, or when the waters are low, of which such use may be made, by a good Engineer, as to shorten the Siege considerably.

The *Rhine* has that particular quality, of always overflowing in the hottest season of the year, by the melting of the snows on the mountains in *Switzerland*.

As there are few Places but have rivers running by or through them, convenient for traffick, it is the business of a chief director to draw all advantages from such a situation, to carry on his Attacks; sometimes when it is but middling, the Attacks are made on both sides, for the conveniency of bringing the Artillery, stores and ammunition by water near the place where they are wanted, as Prince *Eugene* did at the Siege of *Lisle* in 1708; tho' he knew very well that the front which he attacked was not the weakest. Many other advantages may accrue from such situations, which are impossible either to be foreseen or described; and only observed by an able Engineer, who is upon the spot.

*Explanation of* PLATE XIX.

- A. Cavaliers of the Trenches.
- B. Stone Batteries.
- C. Batteries to make breach in the ravelin before the horn-work.

H 4

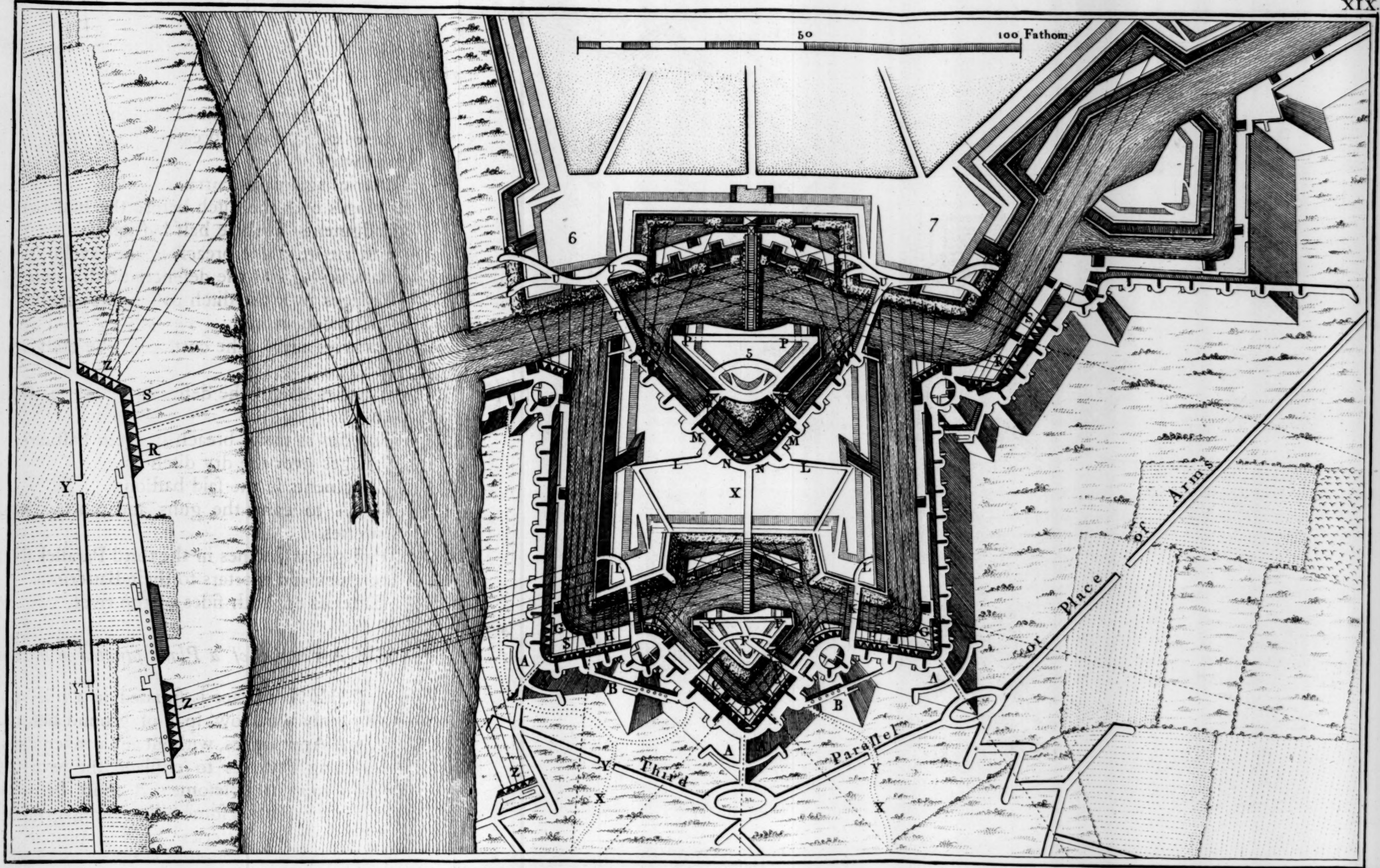
D. Bat-

- D. Batteries against the defences of the ravelin.
- E. Passages over the ditch before that ravelin.
- F. Lodgments in it.
- G. Batteries against the flanks of the horn-work.
- H. Batteries to make breach in the faces of the horn-work.
- I. Batteries against its curtain.
- K. Passages over the ditch before the half bastions.
- L. Lodgments in these half bastions.
- M. Batteries to make breach in the ravelin 5.
- N. Batteries against the defences of this ravelin.
- O. Passages over the ditch before the ravelin.
- P. Lodgments in it.
- Q. Batteries against the curtain of the body of the Place.
- R. Batteries against the defences of the bastions 6 and 7.
- S. Batteries to make breach in these bastions.
- T. Passages over the dry ditches.
- U. Lodgments in the said bastions.
- X. Roads to carry the guns and mortars to their Batteries.
- Y. Passages of fascines in the third Parallel to carry the guns and mortars to their Batteries.
- Z. Batteries on both sides of the river.

*The A T T A C of a Place situated on a Hill.*

**W**HEN a Place is situated on a hill, having only a narrow spot of ground before it to make the Approaches, without any convenient place for erecting Batteries to enfilade the works; the Attac is very troublesome: it must be observed whether there is not some hill or rising-ground near enough to make Batteries, so as to plunge or enfilade







filade some part of the Fortification, or if there be any from whence some works may be seen tho' obliquely: but if no such places are to be found, the works must be battered in front, and mortar Batteries must likewise be made to ply them well with shells, to give the Besieged all the disturbance possible.

As to the disposition of the Parallels and Approaches, they must be made and directed as the nature of the ground will allow, to answer as well as possible the desired effect.

It may be observed, that very high Places, when they can only be battered from low grounds, are partly out of reach of the ricochet-Batteries; because when a gun lies with its breech upon the bed, without any coins underneath, it seldom rises its direction, above twelve degrees; which range will hardly reach any work above fifteen fathoms high.

When Approaches are to be carried from a low-ground to a Place situated on a high-hill; all possible expedition must be used to get near the works of the Place so soon as can be; and the Trenches must be made very deep and narrow. For such a situation gives the Besieged not only an opportunity of plunging into the Trenches, but likewise of sallying with great advantage, which renders the supporting the trenches very difficult and dangerous.

Places situated on hills have generally no other but rain-water within their walls, so it must needs be scarce in dry weather; for which reason every possible precaution should be taken to secure all the springs and brooks which are near the Place; by  
which

which the garrison will be so straitened as not to be able to hold out long.

When a Town situated on an eminence is surrounded with rocks, having little or no soil to cover them, the Attac becomes very troublesome, and next to impossible; such is *Luxembourg*, where the only side that can be attacked is all rock, covered with no more earth than a foot or eighteen inches: there is no other remedy to be found in that case, than to supply the want of earth by wool-packs, gabions, fascines, and sand-bags.

It often happens that these Places are cut into the rock, so that the best part of their revetements are of solid stone; then the fixing the miners, or making Breach with guns, becomes very tedious and troublesome, and the more so in proportion as the stone is harder.

The rock must be well examined to know whether there are no veins that are softer than the rest, which is often the case; and when there are any such veins to be found, the work will go on much faster: but on the contrary, if the rock is every where equally hard, there is no other remedy but time and patience. *Goulon* proposes making the descent into the ditch, by a hole made near the counterscarp so deep as possible; he supposes a ditch of 30 feet deep, and the hole about 6 or 7, which he says may be done in 7 or 8 days; at the bottom of this hole two Mines are to be made, one at each side; and before they are sprung, a great quantity of fascines, stones, earth, &c. are to be thrown into the ditch just opposite to them, which, together with the rubbish of the Mines, will make an easy descent.

To make Breach, he would have 7 or 8 pieces of cannon to batter the wall where the rock ends  
and

and the masonry begins, and from thence upwards, that the rubbish and earth together may make a slope of pretty easy ascent: if the Breach should not be sufficiently wide, the miners may enlarge it by working into the rubbish, and placing some Mines there, which, when sprung, will not fail of making the Breach the necessary width.

*The ATTAC of a Place near the Sea.*

THE Attac of such Places is not likely to succeed unless the Besiegers are masters at Sea, so as to block up the harbour, and prevent the Besieged from receiving any relief that way. When *Ostend* was formerly besieged by the *Spaniards*, it held out three years, the *Dutch* supplying it continually with necessaries of all kinds by Sea, because the *Spaniards* had no shipping to block up the harbour, whereby it was enabled to make that long defence; whereas the defence that the same Town made in 1745, was the least of that nature that ever was known, for it held out but 12 days from the day of investiture to the end of the Siege. The Besiegers found means to raise Batteries which commanded the entrance of the harbour; so that no ships or boats could either go out or come in without great danger. The bad condition of the sluices, neglect of the fortification, and a general want of every thing necessary in the defence, occasion'd the shortness of the defence.

It is not always sufficient for the Besiegers to be masters at Sea, and to block up the harbour, unless farther precautions are taken; for the Besieged may watch and take the opportunity of a dark or foggy night, to pass by the fleet unperceived, with  
small

small boats, and supply the Town with necessaries; and therefore a boom, or several chains should be fasten'd cross the entrance of the harbour; and for a farther security, small boats with lighted torches should row up and down along the shore all night; by which means it would be impossible for any thing to pass by, to leave the Besieged the least hope of succour that way. Sometimes a stockade is made cross the harbour, which effectually secures the entrance; as the famous cardinal *de Richelieu* did at *Rockelle*. The Harbour being well secured, the Trenches are carried on as before directed; their figure and situation must be made as the nature of the ground will permit; in the mean time the ships firing both with their guns and mortars, will contribute much to a speedy surrender. The Attac of such a Place is generally made near the sea side, where there are frequently hills of sand blown there by the winds, under cover of which the Besiegers may approach the Place very near, and make Batteries behind them, to annoy the works; this was the case at *Ostend* in the last Attac, the Town being surrounded with water every where, except at the north side near the sea, where there are sand-hills reaching almost quite to the out-works, behind which the *French* erected Batteries so near the Place, that the Besieged were so soon obliged to surrender.

*To prevent Succours being thrown into a Town.*

**I** Have hitherto supposed the General to have taken every necessary precaution to prevent the enemies throwing any succour into the Place, and to be in a condition to withstand any attempt that may



may be made to relieve it; but as I have not yet entered into any particulars, it will not be improper to expatiate a little on this useful part of the attacks, upon which the success of a Siege very much depends.

It has happened sometimes, that the enemy who had been thought in too weak a condition to relieve the Place, were afterwards found able either to raise the Siege, or to throw such succours into it, as to make it a hard task to take it: the enemy may be strengthened either by drawing out most of the troops from the neighbouring garrisons, which are least exposed, or by a strong reinforcement received from some other part. In such cases,

There are two ways of preventing succours being thrown into a Town besieged, the one by remaining in the line, to hinder the enemy from breaking thro'; and the other, by drawing out as many troops as can be spared, without leaving the Trenches and Line unprovided against any sally the Besieged may make, to engage the enemy upon an advantageous spot of ground.

Both these ways have been practised, and both succeeded sometimes, and at others miscarried; so that it is hard to judge which of them is preferable to the other. The inconveniency arising from keeping within the Line is, the uncertainty on which side the enemy intends to make the Attack; whence arises a necessity of guarding equally all the posts, which when the Line is pretty extensive, or the Army of the Besiegers not very strong, gives the enemy an opportunity of attacking any part with great superiority and advantage; and when once they have broke in, the Besiegers placed there,  
instead

instead of charging them, yet in disorder, usually give all over for lost, and taking to their heels, set an example for all the rest to follow; whereby the enemy succeed to their utmost wishes, without any farther trouble or danger. This has been the case of most Lines that have been attacked and forced.

The inconveniences arising from going out of the Lines, to engage the enemy at a distance, are, that the army must be divided, so as that one part may guard the Trenches, whilst the other meets and opposes the enemy; which weakens it so considerably, that if they are pretty strong, they may be in a condition to beat the Besiegers; or if they do not think proper to engage, may draw them one way whilst a succour passes another.

If the Besiegers are determined to stay within the Line, the General should take care that it be every where in a good condition; the bridges of communication every where in good order, and of a sufficient number; that the troops may be in a condition to succour one another, upon occasion, without any impediment; out-works should be made in those avenues which are most exposed and likeliest to be attacked; that the Line be every where equally guarded, those parts excepted only which are inaccessible, as some generally are; to keep a strict watch upon those parts where there are any hollow ways or rising grounds, under cover of which the enemy may approach unperceived; to place redouts even at some distance beyond the Line, if the situation should be favourable to the enemy; parties and spies to range continually about, to give timely notice of the enemy's approach; for if the Line is well made, and the enemy's

enemy's design discovered betimes, any attempt upon it may certainly be prevented.

In a country where wood is to be had, fires may be made in the night without the Line, about 100 yards distance, opposite to every salient angle of all the redans, whereby the approach of the enemy will be discovered, and his design frustrated.

But if, notwithstanding all the precautions taken on the part of the Besiegers, the enemy should resolve to attempt the relief of the Town, by attacking the Line in some part or other, a signal must be made to notify their approach, and on which side; whereupon the troops next at hand immediately march to the assistance of those attacked, to keep the enemy in play till others can come up, which are at a greater distance; then vigorously charging the enemy upon their first entering the Line, while they are yet in disorder, and, if possible, to drive them out again. It will be necessary to keep guards, at the same time, all round the Line, at proper distances, lest they should make an attack on one side, whilst they attempt to throw in succours on another.

I am persuaded that if the Besiegers knew their advantage, and did not give all over for lost, as soon as the enemies are broke in, and would charge them briskly before they have time to put themselves in order, few or no Lines would be forced, supposing all the precautions before-mentioned were observed.

But if the Line should be too extensive for the number of the Besiegers to defend, or the enemy should appear and be ready to attack them, before the Line and bridges of communication are finished, in that case, it would be most convenient to march out

out and attac the enemy before they advance too near, and before either those in the Town have any notice of their arrival, or they themselves find means of throwing some relief into the Town.

So soon as intelligence has been received of the enemies approach, a convenient spot of ground must be chosen for the field of battle, if possible either near some defiles, through which they must necessarily pass, or some place where Batteries may be erected on a hill or rising ground, or else near some village, where the troops being posted, may flank the enemies in their Attacs. The knowledge and skill of the General is here to be displayed, to procure all the advantages which the nature of the ground can afford; and the disposition of his Army ought to be such, as not to be either surprized or flanked by the enemy, but, on the contrary, to afford mutual succours to one another, whenever it is necessary.

### R E M A R K S.

**T**H E R E are various opinions concerning the Defence of Lines, but the greater number is on the side of those, who think it is more advantageous for the Besiegers to meet their enemies, and fight them before they come too near, for such and other reasons as have been mentioned before; but to set the one and the other manner into as clear a light as can be done, we shall here give some examples, both of Lines which have been forced, and others which were not.

When Prince *Eugene* besieged *Belgrade*, the *Turks* came with an Army of 200,000 men, and besieged him in his camp, making Approaches in the



the same manner as if before a Town; yet though his army was only 40,000, and the *Turkish* garrison nearly equal to his whole army, he marched out of the Line in a foggy night, about three in the morning, attacked the advanced guards of the *Turks*, drove them back upon the corps that should have sustained them, and these falling back upon the others, put their whole Army into confusion, which afforded Prince *Eugene* an opportunity to rout them; a great number were slain, with their general; all done with so much expedition and secrecy, that he was returned to his camp before the garrison knew any thing of the affair, which surrendered the day following.

When the *Turks* besieged *Vienna* in 1683, and the christians appeared under the King of *Poland* and the Duke of *Lorrain*, to relieve it, the *Turks*, trusting to the superiority of their Army, kept within their Line, but were defeated, lost all their Artillery, baggage, and the greatest part of their Army.

The Lines the *Spaniards* made at *Arras* were the strongest ever known, yet they were forced, by Mess. *Turenne* and *Laferté*, with very little loss on the side of the Assailants, who had made three different real Attacks, besides some false ones.

At the Siege of *Turin* in 1706, Prince *Eugene* forced the *French* Lines with 72,000 Men in them, himself having 24,000 only; he attacked them in a post where the Lines were neglected, and the communication of that quarter with the others very bad.

It appears from experience, that it is seldom in the power of the Besiegers to prevent the Town from being relieved, without an Army of obser-

vation; in the few instances following, where the Lines have not been forced, it was chiefly owing to the great superiority of the defenders; as at *Philipsbourg* in 1734, the *French* had a numerous Army, the Line of a small extent, and extremely well made; whereas Prince *Eugene* had no more than 30,000; so that it would have been a very great imprudence to have attempted any such thing.

But when the Besiegers have an Army of Observation, it is hardly possible to force them, and relieve the Town; the only thing that the Besieged can do then, is to attac a Town of the Besiegers, whereby they will be either obliged to raise the Siege, or see a Town of theirs taken.

When *Lisle* was besieged in 1708, Prince *Eugene* commanded the Attacs, and the Duke of *Marlborough* the Army of Observation; whenever the *French* made any motion towards relieving the Town, the Army of observation was immediately reinforced by as many troops as could conveniently be spared from the Trenches, which prevented the *French* from venturing to attac the Allies, and tho' they had a numerous Army, were obliged to remain quiet spectators of the Town's being taken.

#### *Of the raising a SIEGE.*

**N**OTWITHSTANDING all the precautions that a diligent and knowing General may possibly have taken, before the Attac was made, to prevent any relief being thrown into a Town, it will sometimes happen, that the Enemy, by some means which could not possibly have been foreseen, may become so strong, as not only to be in a condition to raise the Siege, which is oft done

done with an inferior Army, but also to give battle with a superior force; then it is prudent in a General to raise the Siege, and retire betimes as privately as he can, thus:

First, to draw off the guns and mortars from their batteries; then the tools are put into the waggons at dusk, the Artillery sets out first, then the baggage, the guard remaining in the Trenches, firing in the same manner as if the Attac continued; and when they are advanced pretty far on their march, the troops follow in a regular order, and the guard of the Trenches draws off by degrees, and follows after; the fires in the camp are all the while left burning as usual, to conceal their retreat from the garrison, who otherwise might fall on their rear.

When there is no danger of a pursuit, the Artillery, baggage and Army draw off by day, with colours flying and drum beating, in the order spoke of; but should it happen that the enemy, by forced marches, come unexpected, so as to leave no time to carry off every thing; then what remains must either be burned or destroyed, that it may not be of use to the enemy.

*The Attacs of FORTS, CASTLES or HOUSES.*

**I**N the course of a war, it oft happens that places of little importance, yet necessary to be taken on account of their guarding some passes, or serving to harass the foragers, fall on convoys, or exact contributions, &c. As such places do not require the attention of a whole Army, some officers with detachments are sent to take them.

These places, for the most part, are no otherwise fortified than by single walls, without a rampart, sometimes with a ditch about them, and a ravelin or redoubt palissaded, to cover the gate or entrance. A detachment sent on such undertakings, should be provided with some small field-pieces, and a few small mortars, and set out so as to arrive before the place about dusk; they immediately make some epaulement near the place to be attacked, to cover their troops, guns and mortars, and so soon as they can see, begin to fire very briskly till a breach is made, or the enemy think proper to surrender.

If guns and mortars cannot conveniently be transported, on account of bad roads, or of the great expedition which is oft required, to surprize and leave no time to the Enemy to strengthen the garrison, or else there is an expectation of doing the business without them, it will be of importance to be well acquainted with the place, and the nature of the ground about it; and so soon as the detachment is arrived, to make a false Attac on one side, to draw the whole force and attention of the enemy that way, while a party scales the wall, or enters by any other means on the other; and if they succeed, march directly towards the gate, break or cut it open, and then fall suddenly upon the garrison, and attac them vigorously till they surrender; but in case they should not succeed, a retreat is beat to retire in the best manner possible.

Petards are oft of great use in these kind of Attacs, for breaking open the gates, forcing barricades or palissades; if they can by any means be fixed, they never fail of their effect.

*Feuquier* carried off many garrisons, both in Germany



many and in *Italy*, by them, which could hardly have been done by any other means.

If a Castle stands upon a high hill, so that the guns can have no effect upon it, or the shells thrown into it, oblige the enemy to surrender, as is very oft the case in *Germany* or *Spain*, where most Castles are built upon high places; then a large Mine must be made, if the Castle is of importance enough to be taken, which being loaded with a great quantity of powder, and before the Mine is fired, notice is given to the garrison of their danger, which generally makes them surrender.

In king *William's* war the *French* made a Mine under the Castle of *Alicant* in *Spain*, and when it was loaded they summoned the garrison, who were *English*, to surrender; but some of the officers, to shew their bravery, thinking themselves secure, were swallowed up in the gap which the rock made, with their Punch-bowl.

If a small Place is neither to be surprized or forced, by any of those methods, some Infantry must be placed in such a manner as to fire continually at the enemy, wherever they appear, and in the mean time the gate must be forced open, either with a Petard, or cut with hatchets; but this must be done suddenly, before the enemy have time to consider of what is doing at the gate, to secure the grenadiers in this dangerous undertaking.

If the enemy should have retrenched or baricaded themselves in a House, Farm, or Church, which is not to be forced, without some kind of small Artillery, it may be set a fire to make them surrender. Unfair as such ways of proceeding may appear, war is an excuse, that allows of every strata-

tagem. The *Hungarian* hussars have oft practised this method with success.

*The surprizing large Places.*

**I**F the Governors were continually upon their guard, and strictly observed military discipline day and night, it would be a hard task to surprize a Place so guarded; but it oft happens that a Governor lives in too great security, and neglect of all discipline, especially when the enemy are at some distance, and other Places between them; of which an active and skilful General knows how to take advantage, and to lull the Governor in his security, by giving out, in a private manner, that he intends to undertake something quite contrary, in the mean time he is preparing every thing necessary for his expedition; he should be informed, by spies, of the strength of the Place and garrison, what troops, whether Veterans or militia, all the centry-posts, the guard-houses, and strength of each guard, where the soldiers are quartered, in baracs or private houses, the situation of the Governor's house, and of the store-houses, the place of parade, where the troops assemble, whether any posts are guarded with less diligence than others, on account of their distance from the parts where they imagine the enemy may be expected; it is also necessary to be acquainted with the courage and capacity of the Governor, and of the principal officers, the nature of the ground about the Place, whether there are any woods, hollow roads, under cover of which the troops may approach unperceived. This being known, and the troops before the Place, while yet dark, it must be

be determined where and which way to enter the Town; or sometimes in foggy mornings, when the gates are opened, by lying hid in troops at hand, approach instantly and seize on the draw-bridge, to prevent its being drawn up, and keep the guards in play, if they cannot surprise them, till others may arrive; or get a cart loaded with fruit, which they stop, under some pretence, by the guard-room, let them fall out to amuse the guard, which they seize, being under disguise of peasants, or stop upon the draw-bridge, and drop one of the wheels, to prevent its being drawn up; or sometimes this is to be done by means of some old aqueduct or underground passages that has been neglected; sometimes a number of officers and soldiers enter in disguise, some one way and some another; when they are got safe into the town, they harbour either in public houses or in those of people, bribed to receive them, and so soon as it is dark, and the garrison lies secure in their beds, all assemble at a place agreed on, and from thence march directly to the gates and other posts, and surprise the guard, sending word, or making signals to the troops without to approach and break open the gates; so soon as these are got in, they march directly to the barracks, to prevent the garrison from taking to arms, and, at the same time, send a party to secure the Governor; others to take all the considerable posts, such as Store-houses, powder-magazines, and especially the ramparts, to prevent the garrison from making use of their cannon.

Should there be any strong hold within the town, as a Castle or Citadel, care must be taken that the garrison do not throw themselves in it; and in case of any resistance from thence, the guns of the

town may be turned against it, to reduce it as soon as possible.

*Cremona* being garrisoned by the *French*, was surprized by Prince *Eugene*, who took the Governor and M. *Villeroy* prisoners; but a regiment of the garrison happening to be accidentally under arms, by some mistake of the time, made an alarm, and the officer of Prince *Eugene*'s party, who was to have given the signal to those without, was killed in the first Rencontre, the troops without, not having the expected signal, and hearing the firing and noise in the Town, marched off giving all over for lost; which obliged Prince *Eugene* to retire, after he had been nine hours in possession of the Place.

As nothing is more instructive than examples of facts, I shall here give a few more.

*Feuquier* commanding at *Pignerol* in 1691, surprized *Savillan* with four companies of the King of *Sardinia*'s gens d'armes in it; in this manner; in the evening of a frosty night, he set out with 800 horse, having 500 foot behind them, and made such haste as to arrive two hours before day; he approached with his foot to a detached bastion, which he knew had no revetement, entered the ditch, passed over the ice, to the entrance of the Place, where he enter'd, having the lock broke open by a spy sent before; then drew up his foot, and surprized the guard, broke open the gate to let in the horse; which done, the garrison was taken, without any resistance, and carried to *Pignerol*: all executed in thirty hours, tho' these two Places were above fourteen leagues asunder.

The same Officer being quartered at *Hailbron* in 1688, marched with 900 horse and 800 foot to a little place called *Kreilsheim*, in the country of  
*Anspach*



*Anspach* on the *Neker*, the garrison consisted of two battallions, inclosed by a good wall, a ditch round it, and a Castle within; as it could not be surprized, he perswaded the Governor to come out under some specious pretence, upon which *Feuquier* commanded him to summon the garrison to surrender prisoners of war, which they did.

This shews, how cautious a Governor should be, and not leave his garrison without being well escorted, or trust an enemy without great necessity.

The same gentleman commanding at *Pbortzheim* upon the *Lentz* in 1689, being much straiten'd by two posts of the *Imperialists*, the one above and the other below him; for they placed guards upon hills so near, that they could discover whatever came out of his garrison: to get rid of such troublesome neighbours, at dusk he marched out with 600 foot, took a great circuit, and arrived before the gate of *Neubourg*, one of these posts, which was least guarded, about midnight; where passing over the bridge to the gate, told the centry, in *German*, that he came from a party, and desired to let them in; whilst they sent for the key to open the gate, he amusing the officer of the guard with stories, the Petard was fixed before it was perceived; they immediately fired at him and his men, and beat the alarm; but it was too late, for they got in, and were drawn up before the garrison could be brought under arms, and so were taken, consisting of 500 foot, 150 dragoons, and about 300 horses.

The very next night he marched with 600 foot and some horse to *Entzwabing*, which was the other post, being only guarded by 150 foot, and  
500

500 horse, sending his horse over the River *Lentz*, to prevent those of the garrison from running away, and attack both gates at once, knowing they were but slightly guarded, some cutting the palissades placed in the form of a redan to cover the gates, whilst the rest fired smartly at the guards; an opening being made, the gates were forced and the garrison taken.

These two garrisons, consisting of 1300 men were put to the sword, as a sacrifice to the manes of 30 troopers which the *Germans* had cut to pieces in cold blood; a terrible revenge of a provoked and cruel enemy.

The King of *Sardinia* having a company of gens d'armes in the Castle of *Orbassan*, a league from *Turin*, to cover his going to a pleasure-house he had there; *Feuquier*, always upon the watch, finding they thought themselves secure, and neglected their duty; set out from *Pignerol* in the dusk with 800 horse and 500 foot; and when he came near the castle, detached his horse towards *Turin* and *Montcallier* to watch the enemy who might come that way, and advanced with his foot to the gate, where he ordered a Petard to be fixed; the centry perceiving it, killed the Petardier and alarmed the garrison; however, he himself fixed the Petard, as having no body else that understood the business; by which the gate being broke, he took the garrison in the midst of the King's quarters, and carried them safe to *Pignerol*, without the least pursuit.

*The taking a Place by Escalade.*

**T**HE manner of taking a Place by Escalade, is much the same as that of surprising it by any other stratagem; the only difference is, in passing the ditch and mounting the rampart by means of ladders. The scaling ladders used, upon these occasions, are of various sorts; some are of ropes, and some of wood, some are made of several joints, so as, when put together, to make a ladder of any length, which, in my opinion, are the best, for the height of the wall is seldom known till you come upon the spot; therefore no proper length can be given to the ladders before-hand; there is another sort used in *England*, much of the same make as the common ladders, only the steps turn about wooden pegs, so that the poles may be brought near each other, or to shut like a parallel ruler: this ladder is very convenient for carriage, but as they are of a certain length they are not so useful as those with joints.

Being arrived before the place in the night, the first thing to be considered is, where and in what manner to pass the ditch; when it is dry and deep, there needs no other consideration than how to get into it; if it is muddy, boards, hurdles, or fascines are to be thrown in; but if it is full of water, the passage is like to be troublesome, but it often happens that a Governor, because the Town seems to be in no immediate danger of a surprize, grows careless in his duty, and negligent of discipline, and by that means may be easily surprized.

When a river passes by or through a Town, a great number of boats must be provided in as private a manner

a manner as possible, and brought in the dark, to be ready to carry the troops over, in the middle of the night, or early in the morning, about an hour before day.

But if there is a deep wet ditch, which has no communication with any river, small boats made of Tin should be provided, each to hold one man only; sometimes baskets covered with skins or oil-cloth, have been used on such occasions; these kind of boats being very light, are easily carried by the detachment; and when the first have passed the ditch, they push the boats back for others to get over, till all are passed.

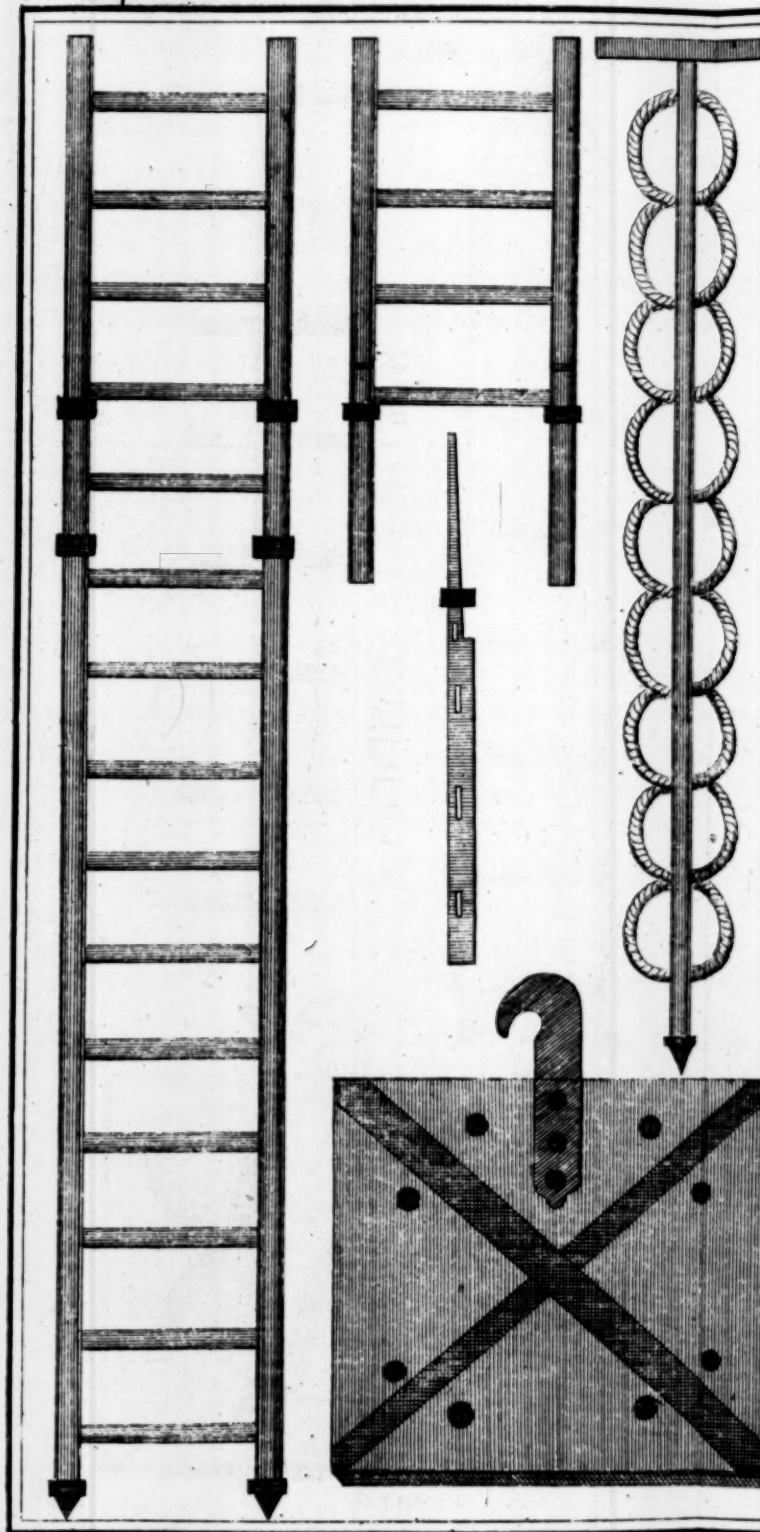
Supposing then the troops prepared to pass the ditch, by some means or other, a party must first be placed on the counterscarp opposite to the landing place, ready to fire at the garrison, in case they have taken the alarm, and come to oppose their mounting the rampart. If the ditch is dry, the ladders are fixed in some place farthest distant from any centry, and so soon as they get upon the rampart, they put themselves in order, to be ready to receive the enemy, if they should appear; then the commanding officer, or some trusty man, who speaks the language of the garrison, advances at some distance before the rest, towards the gate; if he meets with a centry, he goes up to him, under some pretence or other, as if he belonged to the garrison, and if the centry suffers himself to be thus surprized, claps a pistol to his breast, to keep him quiet; but should the centry, knowing his duty, offer to keep him at a distance, he must endeavour to kill him with all possible silence, and then advance suddenly with the detachment towards the gate, and either surprize or kill all who oppose them;

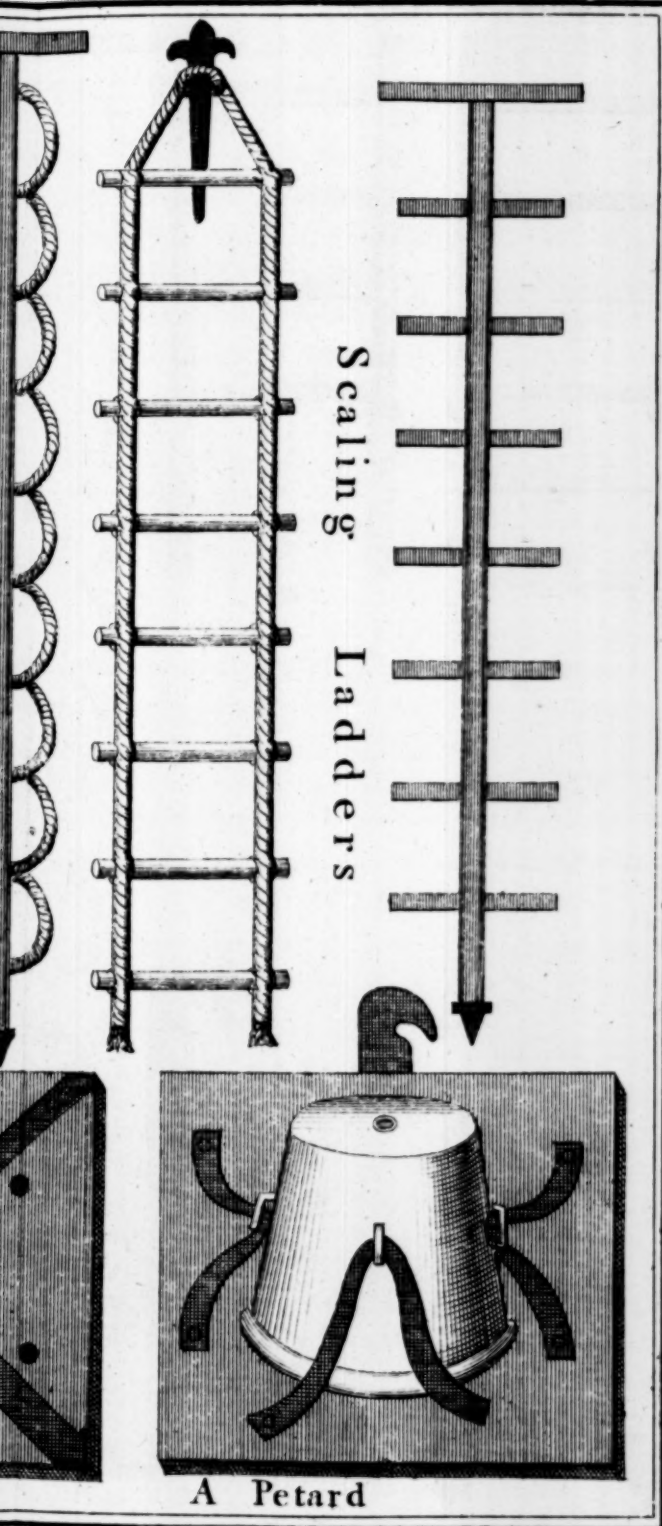


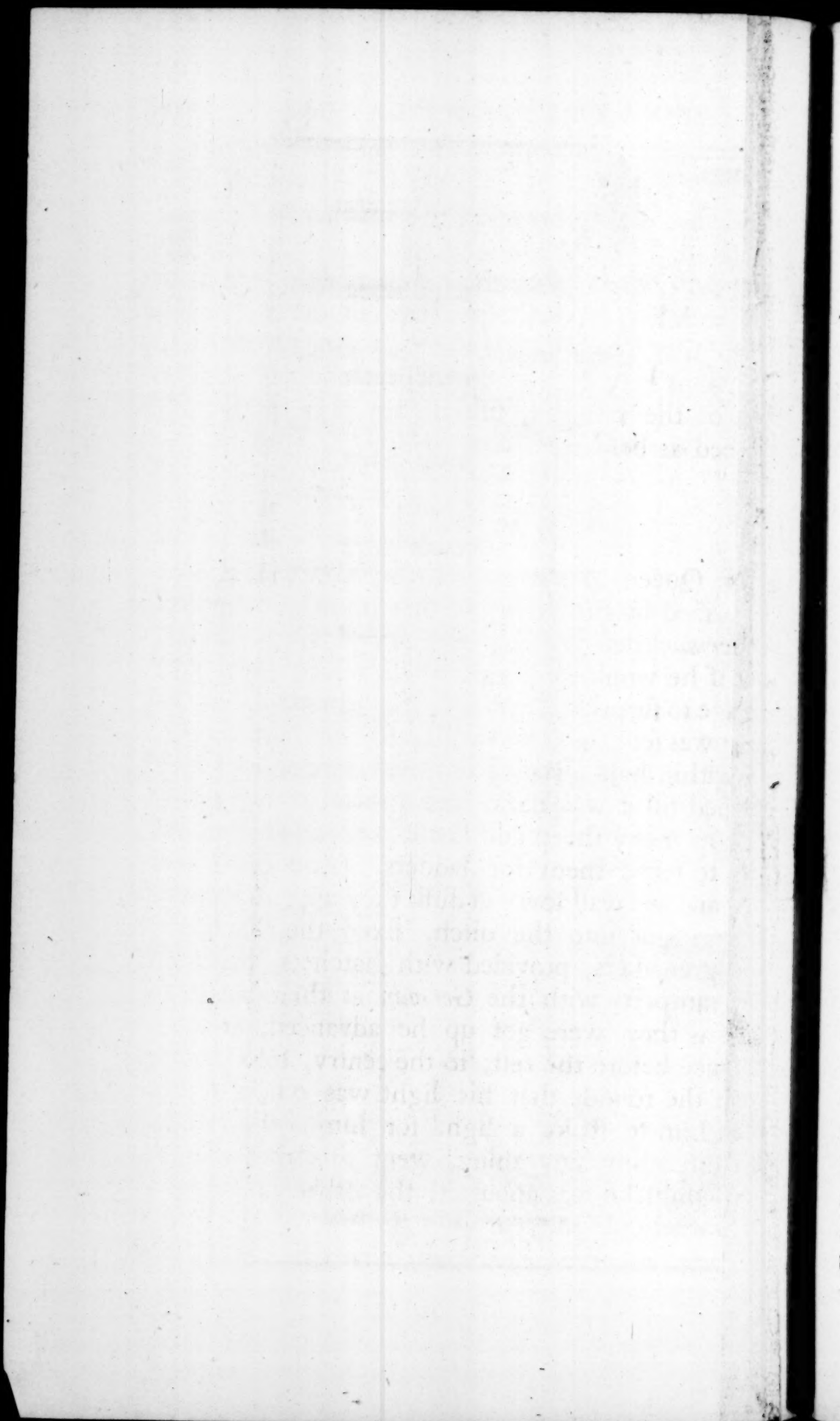
to  
of  
ur

no  
de  
an  
il-  
nd  
he  
he  
get

he  
rft  
d-  
ey  
eir  
he  
m  
n-  
to  
en  
ho  
at  
e ;  
er  
he  
us  
im  
ty,  
ur  
d-  
he  
ofe  
n ;









them; immediately upon this they fall to work breaking open the gate, to let in the rest of the party, and then proceed in the manner before described.

If the ditch is wet, the rampart high, and has a revetement, it will be hard to surprize the Town that way; but if there is no revetement, the troops may hide themselves along the outside slope of the rampart, till all are over, and then proceed as before.

### R E M A R K S.

**I**N Queen *Ann's* war, *Keiserflautern* was surprized by the *French* in the following manner. A *German* deserter told the *French* Commander, that if he would send a party with him, he would engage to surprize the Place; accordingly a detachment was sent, which marched through the woods, till within half a league of the Place, where they stopped till it was dark, and provided themselves with as many sheep and horse racks as they could get, to serve them for ladders. The ditch was dry, and the wall low; at dusk they approached the Town, got into the ditch, fixed their ladders; 400 grenadiers, provided with hatchets, mounted the rampart, with the *German* at their head; so soon as they were got up he advanced, at some distance before the rest, to the centry, told him he went the round, that his light was out, and desired him to strike a light for him; the centry, not suspecting any thing, went to strike a light, and whilst he was about it, the other gave him a blow with an iron bar, which he had ready for that purpose, by which he threw him into the ditch;

ditch; the grenadiers upon this immediately advanced to the gate, surprized the guard, and opened it. The garrison finding how things went, withdrew into the Castle; and when the inhabitants had ransomed the Town from plunder, the *French* retired, as they could not keep it for want of the Castle.

In the year 1676, *Loo*, a Town on the River *Dender*, belonging then to the *Spaniards*, was surprized by the *French*. The ditch was wet, and the rampart without a revetement; half the detachment passed the ditch in small baskets covered with oiled cloths, while the other half stood ready to fire upon those who should oppose their passage, then followed the rest in the same boats, and took the Place.

When the Army is very strong, and the place very large, and not regularly fortified, several attacks may be made on different parts, at some distance from each other, some of them may be false ones, and begun first to favour the real ones; this may be done with scaling ladders, petards, and boats, if the whole ditch or part of it is dry. It was in this manner that the *French* and *Prussians* surprized *Prague* in the last war, just before a strong reinforcement which was a coming, could get into the Town. These and many other stratagems may be used to surprize a place, which seldom fails of success, if the undertaking is carried on with resolution, and well concerted. I am fully persuaded, that many places that make a long defence when attack in a regular manner, might be taken at a sudden attack on all sides, if it can be before the garrison is reinforced. It is true that such an attack may be looked upon as desperate, and it might expose the troops to great danger;  
but

but when we consider the great expence of a siege, the time, and the number of men lost, it will appear, that even by losing the same number of men, in a sudden assault on all sides at once, there would be much time and expence saved.

*How and when a SIEGE may be accelerated.*

WHEN a garrison is very small, in comparison to the extent of the Town, or the Army of the Besiegers very numerous, there is no necessity for strictly observing all the precautions mentioned in the Attac of a place regularly fortified; for which reason the Line of circumvallation is oft omitted, as I am told the *French* did last War at *Tournay*, tho' the Town was well fortified, and had a very strong garrison; but the Besiegers were so numerous, that they were under no apprehension of any attempt for its relief.

In such cases an extraordinary number of workmen are employed, who carry the trenches within 100 or 150 yards of the Town, the first night, and there the first parallel is made, erecting likewise some batteries with gabions and sand-bags.

When a garrison is weak, the works of the Place out of repair, without any revetement, and but few or no out-works; or when there are any hollow ways or cavities near the Town; then, instead of opening the Trenches at 800 fathoms distance or more from the Place, as before, the Besiegers advance the first night near or on the glacis, where they make a Parallel, and erect batteries; and when this work is so forward as to cover the troops, then they work backwards; that is, they carry a trench or two from the Parallel already made back-

backwards towards their camp, for the troops going to or coming from the Parallel to the camp in safety, and at the same time carry their lodgments forward on the ridge of the glacis.

If the garrison is very weak, the works made with turf, and out of repair, the Besiegers may advance to the covert-way the first night, drive out the enemy, and lodge themselves there, if it would prove too dangerous to assault the body of the place at once. It would be proper to carry some small field-pieces along with them, to discommode the Besieged, till their batteries are raised, and a good number of wool-packs to cover their troops in the covert-way, till their lodgments are made ready to receive them. For it is not sufficient to advance a siege only, without taking care, at the same time, to lose so few men as possible, that the advantages gained one way, may not be counter-balanced by the loss on the other.

When a Siege is undertaken, the first consideration is, how to proceed so as to become master of the Place in the shortest time and safest way, sometimes attacking it in a regular manner, when it cannot be effected otherwise, sometimes advancing pretty near the Place, under cover of some rising ground, hollow roads, caverns, or buildings, which the Besieged may have neglected, or had not time to destroy; sometimes by attacking the Town on one side, and scaling it on the other; or surprizing some of the out-works, especially when they are made with sods only. In short, a skilful Commander should use all kinds of stratagems to over-reach the enemy, and if not in the whole, at least to surprize them in part, and never omit the least favourable opportunity, arising either from



from the nature of the ground, indolence of the Governor, or ill condition of the work, which may any ways contribute to shorten the Siege. But as it is impossible to enumerate all the various cases that may happen, and which depends chiefly on the time, opportunities, and situation, we shall insist no longer on the Attac of Places, but proceed to their Defence.

---

## P A R T II.

*Of the* DEFENCE.

**I**N the first part I have explained the particulars of the Attac of Places, the second treats of every thing concerning their Defence: there is such a connection between these two branches, that it may not altogether appear improper to treat of them together in the same manner as *Goulon* has in his memoirs, were it not more proper with regard to the perspicuity of the subject to separate them; the Attac teaches the elements of Defence in general, I shall here treat more particularly of what may be useful in the Defence of each part, or in any manner conducive to a long and vigorous Defence of the whole.

The Design of this work being to point out the principal means to be used in the Defence of a Place; I shall begin with the necessary garrison and quantity of ammunition and provision requisite in proportion to its bigness, and the general disposition which is to be made, to make a brave and stout Defence; after this we give the particulars relating to the Defence of each part of the Fortification, and then an explanation with regard to the Defence of small Places, Castles, and even of Houses, capable of receiving a guard, with a view to rouse the attention of young officers, and to shew that there are few posts but may be defended against an attac of a short duration; and that these kind of Defences have their use, and are not altogether

together romantick, when well conducted by brave and skilful Commanders.

TROOPS *and* AMMUNITION *required in a* FORTIFICATION *to make a good* DEFENCE.

THE Defence of a Place depends not only on the goodness of its Fortification, but also on the strength of the garrison, the quantity of Artillery, ammunition, and provision; and above all, on the courage and conduct of the Governor.

It is not sufficient that a Governor is brave, and ready to expose himself upon all occasions to the greatest danger, but he should have a perfect knowledge and skill in fortification, to make a stout and long Defence; by these he will be enabled to make the best use of every minute part of the works, and to defend them with least danger to the garrison, as likewise to make the enemy pay dear for every inch of ground they gain.

But how should it be possible for a Governor to know after what manner to defend the several works with best advantage, if he is ignorant in what particulars their Defence consists? to retire and give way to the superiority of the Besiegers upon occasion, and at a more favourable conjuncture to return to drive them out again, and destroy their works? might not one conclude, without presumption, that the little resistance which some considerable Places have lately made, tho' well provided with every thing, and capable in all other respects to make a long and obstinate Defence, has been owing chiefly to the want of knowledge and skill in the Governors?

It is certain that the success or miscarriage of all great undertakings, especially in the Art of War,

chiefly depends on the knowledge and conduct of the Commander ; since nothing is done without his orders, and every thing is carried on under his direction, both in the projecting and execution.

It is then to be taken for granted, that conduct and knowledge in the Governor is the first thing essentially necessary for a good defence, and next a sufficient garrison, well provided with every thing, both for defence, and enabling them to sustain the great fatigues unavoidable in a Siege.

If it is of importance that the works should be well constructed, it is no less so to have a sufficient number of troops to defend them, since they are made on the supposition that there should be men to defend them, and consequently, the walls without Men, would be but little obstruction to the enemy.

The bigness of a Place, the number of out-works, and the nature of the ground about it, ought to serve as a rule, whereby the strength of the garrison should be determined. It is evident that the larger the Place is, that is, the more bastions it has, the more troops are required for its defence; the same may be said with regard to its out-works: and as to the nature of the ground about it, it is no less evident, that of two Places of equal bigness and equal number of out-works, that which is accessible on every side requires more troops to defend it, than that which is only so in some parts, since the inaccessible sides need not be so well guarded.

Mr. *Vauban* computes the strength of a garrison, by allowing 5 or 600 men for every bastion, regularly fortified with ravelins and a covert-way, and so many for every horn or crown-work, as likewise for a double ditch and covert-way ; but this  
does



does not seem to be sufficient for a Place accessible on every side, especially now, when there is so much Artillery used in the Attacks of Places. There should, in my opinion, be no less than 1000 men allowed for every bastion, and in proportion for any other supernumerary outworks; and if there are any sides inaccessible, to allow only one third for each, that is, 333; besides these, there is allowed one tenth of cavalry; that so, according to this computation, a Place with six bastions should have a garrison of six times 1000, or 6000 foot, and 600 horse, or rather dragoons, who are best, as they charge equally afoot as on horseback; that is, such a Place should have a garrison of 6600 effective men.

It is likewise judged, that eight pieces of cannon and two mortars, are necessary for every bastion; that is, 48 pieces of cannon and 12 mortars, for a Place of six bastions, which in my opinion is not sufficient; I would therefore allow 12 pieces for each bastion, so that the whole will amount to 72 pieces of cannon and 40 mortars, in a Place accessible on every side.

As to gunners and bombardiers, there should be four men for every cannon or mortar, at a time; and to have two days rest, there must be 12 for every piece; that is, 12 times 84 or 1008, or a battalion of 1000 Artillery men.

The number of Engineers must be considered. There should be two to every bastion; so that 12 will be necessary.

Though this estimate is not so exact, as to be depended on in all cases, yet it may serve as a pattern to go by, and may be increased or diminished as occasion requires.

As the Defences of Places equally fortified are so various with regard to the times, that there can hardly be any supposition made about them ; and yet to make an estimate of the ammunition and provision, it is absolutely necessary to be determined ; for which reason, I shall suppose that the Place will hold out six weeks, as it may, if well defended, and make the following computation.

This supposition may not improperly be objected against, since the strongest Places, that were attacked since the beginning of the war in 1740, *Fribourg* and *Bergen-op-zoom* only excepted, have not held out above a month ; and hence it seemingly appears, that this time is more than necessary ; but we are not to suppose, that a Place defended as it should be, may hold out not so long ; on the contrary, it may possibly hold out that time ; besides, it is always prudent to have plenty of every thing, and rather more than what is wanting, than not sufficient.

The garrison of a Place of six bastions, being then supposed of 6000 foot, they should be divided thus ; the number of the sick and wounded in a fortnight's time, and those reserved for helping the gunners on the Batteries, and transporting the ammunition and other necessaries, may be computed at about 600 ; the remainder 5400 serve for the Defence of the Place ; these 5400 are divided in three bodies, of 1800 each, one of them for the guard, one to lie under arms, ready to march on the first notice where wanted, and one to rest, but ready to march upon occasion.

The horse are also divided into three bodies, of 200 each ; one for the guard, which are chiefly placed on the right and left of the Attac ; the others

thers are divided into small detachments, placed in different parts of the Town, to keep the inhabitants in awe, as well as to go upon any expedition; and the third rest, with their horses saddled, ready to mount for marching, if required.

The guard of 1800 foot may be divided into three bodies, of 600 each; two to defend the works attack, and the third to be placed in those works which are not attack; the two first 1200 may be subdivided into three lesser bodies, 400 each; two of which, 800, fire for two hours, the other relieves one of them at the end of that time, the next is relieved two hours after, and so on alternately, that after four hours firing they may have two hours rest.

There is not so much firing required by day as by night; because the Besiegers cannot so well undertake any thing without the knowledge of the Besieged; but in the night their proceedings are not so easily discovered; for which reason there must be a continual brisk fire all night.

By day the troops fire from between baskets, sand-bags, or gabions, placed on the interior side of the parapet, and filled with earth, that being under cover, they may take better aim at their enemies.

To know the quantity of powder required for a Siege of any determined time, it will be necessary to know the quantity expended each day.

According to Mr. *Vauban*, a pound of powder of 16 ounces contains between 30 and 40 charges for common muskets, including their priming; each man may fire 100 charges during the guard of 24 hours; the quantity for each man may be fixed at two pounds at a medium; some will use more and some less.

# 136      A T T A C *and* D E F E N C E

I have supposed that out of the 1800 men for the guard, there were but two thirds placed in the front attacked, that is, 1200 men allowing two pounds for each man, amounts to —      —      } lb. 2400

For the two thirds of those under arms ready to support the guard, that is, 1200 men, at the rate of half a pound each } 600

For the 600 men of the guard placed in the adjacent works of the Attac, at the rate of a quarter of a pound each } 150

For the 200 horse-guard, at a quarter of a pound each } 50

For 300 cannon-shot during 24 hours, at 5 pounds each. —      —      } 1500

The quantity of powder for cannon-shot may be determined exactly when the number of pieces and their callibers are known, by allowing a quarter or one third of the weight of their shot, for each charge.

For 300 shot for wall-pieces, at two ounces each —      —      } 38

Total lb. 4738

This is the quantity of powder expended each day, besides what is used for mortars, grenades and mines.

Now, suppose the siege to hold six weeks, as said before, the expence for 42 days, will amount to 198996 lb.

Or the following quantity; a little more or less being of no great consequence } lb. 200000

Besides, for 1200 thirteen inch shells thrown during the siege, at the rate of 16 pounds each charge —      —      } 19200

For



*of* FORTIFIED PLACES. 137

For 300 eight inch shells, and lesser,	}	18000
at 6 pounds each ———		
For 6000 shots with stone mortars, at a	}	9000
pound and a half each ———		
For 3600 grenades, at 4 ounces each		900
For Mines ———		8000
Powder burnt in the breaches —		4000
For fire-works ———		4000
Allowance for waste and accidents		24900
Quantity which ought to remain at the	}	12000
surrender ———		

Total lb. 300000

Having given an estimate of the quantity of powder required in a siege, the leaden shot is taken at two pounds for each pound of powder; and as there has been found 135996 pounds of powder for musket-shot, and for wall-pieces; twice that number, 271992, or 272000, will express the number of pounds of lead.

As to the quantity of matches, there should be 500,000 bundles.

Provision being of no less consequence than ammunition, it will not be improper to shew how to estimate the quantity required of each sort.

Each man is allowed a pound and a half of bread a day, so that the garrison consisting of 6600 men, they will require 9900 pounds a day, and 42 times that number, that is 415800, for the whole time of the Siege.

A common sack of flower, containing four bushels, weighs generally 200 pounds, and makes 270 pounds of bread; now the garrison supposed to be 6600 men, at a pound and a half a day, amounts to 9900 pounds of bread required for one day, and therefore 415800 pounds for six weeks; which

I have supposed that out of the 1800 men for the guard, there were but two thirds placed in the front attacked, that is, 1200 men allowing two pounds for each man, amounts to —      —      } lb. 2400

For the two thirds of those under arms ready to support the guard, that is, 1200 men, at the rate of half a pound each } 600

For the 600 men of the guard placed in the adjacent works of the Attac, at the rate of a quarter of a pound each } 150

For the 200 horse-guard, at a quarter of a pound each } 50

For 300 cannon-shot during 24 hours, at 5 pounds each. —      —      } 1500

The quantity of powder for cannon-shot may be determined exactly when the number of pieces and their callibers are known, by allowing a quarter or one third of the weight of their shot, for each charge.

For 300 shot for wall-pieces, at two ounces each —      —      } 38

Total lb. 4738

This is the quantity of powder expended each day, besides what is used for mortars, grenades and mines.

Now, suppose the siege to hold six weeks, as said before, the expence for 42 days, will amount to 198996 lb.

Or the following quantity; a little more } lb. 200000  
or less being of no great consequence }

Besides, for 1200 thirteen inch shells thrown during the siege, at the rate of 16 pounds each charge —      —      } 19200

For

# of FORTIFIED PLACES. 137

For 300 eight inch shells, and lesser,		
at 6 pounds each	— — —	18000
For 6000 shots with stone mortars, at a		
pound and a half each	— — —	9000
For 3600 grenades, at 4 ounces each		900
For Mines	— — —	8000
Powder burnt in the breaches	—	4000
For fire-works	— — —	4000
Allowance for waste and accidents		24900
Quantity which ought to remain at the		12000
surrender	— — —	— — —

Total lb. 300000

Having given an estimate of the quantity of powder required in a siege, the leaden shot is taken at two pounds for each pound of powder; and as there has been found 135996 pounds of powder for musket-shot, and for wall-pieces; twice that number, 271992, or 272000, will express the number of pounds of lead.

As to the quantity of matches, there should be 500,000 bundles.

Provision being of no less consequence than ammunition, it will not be improper to shew how to estimate the quantity required of each sort.

Each man is allowed a pound and a half of bread a day, so that the garrison consisting of 6600 men, they will require 9900 pounds a day, and 42 times that number, that is 415800, for the whole time of the Siege.

A common sack of flower, containing four bushels, weighs generally 200 pounds, and makes 270 pounds of bread; now the garrison supposed to be 6600 men, at a pound and a half a day, amounts to 9900 pounds of bread required for one day, and therefore 415800 pounds for six weeks; which

which being divided by the number 270 pounds a sack of flower makes, gives 1540 sacks of flower required for 42 days subsistence of bread to the garrison.

Tho' the garrison diminishes daily, this quantity of bread is not sufficient; because each officer has servants, more or less, according to his rank; and there are besides, women, surgeons. and several artificers of different kinds, that are useful in the Defence.

There must, besides, be at least, three days provisions left when the garrison capitulates, otherwise they are not entitled to a capitulation; for which reason, it will not be amiss to have 2000 sacks, in a Town besieged, such as we have supposed of a garrison of 6600. The *French* allow the same quantity of bread to a garrison of 3960 men; but then they suppose that each man has but half a pound of meat, which is too little, especially for *English* foldiers, who can have no less than a pound and a half, amounting to 415800 pounds for the whole Siege.

There are likewise many other things necessary in a Siege, such as roots, flower for pudding, herbs, pulses, wine, beer, brandy, tobacco, &c. for the subsistence of the garrison; and in general, every thing necessary for the Defence should be provided with great care and judgment, that the garrison may make all possible Defence.

*Necessary Preparations before a Town is invested.*

**A** Diligent Governor should, in time of peace, consider the condition of the Place, in such a manner, as if he were going to be Besieged, not omitting



omitting the least thing that may contribute to a long and obstinate Defence; he should therefore take particular care to keep the fortification in good repair; clearing the country round of all hedges, ditches, trees, hollow roads, caverns, and rising grounds, within the reach of cannon-shot, not suffering any houses to be built within that distance, nor in general any thing to be done that may any ways favour the approach of an enemy.

He should consider well with himself, of every minute circumstance that may be an advantage or disadvantage to him during the Siege; he should thoroughly examine the several works, and canvass all the different stratagems that may be used, either to defend them, or to give way upon occasion, when overpowered, with intent to return and dislodge the Enemy, after they have got possession of them. In short, how to defend his Place, inch by inch, with the best advantage, he should consider how, and in what manner the works defend each other, whether their communications are safe, or if they may be interrupted by the Besiegers; how to incommode the enemies when they are at a distance, or to dislodge them when near; and if the ground be proper for Mines, and where they should be made; if any part of the country may not be laid under water, by means of dykes or sluices; if there are any already made, to keep them in constant repair, or to make them, if they are wanted, taking care to place them so, that the enemy may not have it in their power to destroy them, either with their cannon or mortars.

If he is not sufficiently skilled in the Attac and Defence, he should frequently converse with Engineers and others who understand it; entertain them

them at his table, and by engaging them to speak freely, examine the works together, to see what may be done, to render the Defence of the Place as long as the circumstances and nature of the works will admit of: and to make it familiar to himself, he should set down a project of Defence on paper, and have it canvassed by the most skilful Officers and Engineers about him. This should be done in private, that spies or deserters, may not discover the weak parts to the enemies.

All these things being well considered, when the Town is in any danger of being besieged, the Governor, besides the attention of furnishing the Place with ammunition and provision, should likewise repair those works that want it, and construct, if possible, detached redouts, arrows, and such other kind of out-works, which oblige the enemy to open their Trenches at a greater distance.

The covert-way should be well palissaded; the ditches cleared of the mud, if they are wet; if they are dry, a trench should be carried along the middle of them, ten or twelve feet wide, and five or six deep, and water brought into it, if possible; if any of the out-works have no revetement, but have palissades placed horizontally on the outward slope of their parapets, they should be repaired and kept in good order.

The places of Arms in the covert-way may be retrenched, by raising parapets within parallel to the faces, and making a small ditch before them. In short, the Governor should contrive all possible expedients to lengthen his Defence, and to oppose obstacles to the enemy.

The galleries of the Mines are not to be neglected, they should be made betimes, carried as far

far into the field as the nature of the ground will permit, and their chambers placed under the ridge of the glacis, before the salient angles of the covert-way, as likewise in all those places where the enemy erect their Batteries.

If there are any houses within the rampart, which may obstruct the Defence, they should be demolished, and nothing left either within or without, which may any way favour the Besiegers.

If there are any militia or new-raised troops in the garrison, all possible care should be taken to discipline them as well as time and opportunity will permit.

The Governor should see that the Hospitals are in good order, and provided with every thing wholesome and necessary, that the sick and wounded may be taken care of, when there are any, nor think it beneath his character to visit them, and to shew how much he is affected with their misfortunes; for such instances of kindness, will not fail to engage every man, in time of danger, to do their utmost with pleasure, to shew their gratitude, and to esteem the honour, which the Governor gains by a good Defence, as their own.

As it is usual in Sieges to throw a great number of shells into the Town, it is necessary to have some places under-ground bomb-proof, where the part of the garrison not on duty may rest in safety; they are not so much wanted in large Towns, where there are always some places or other secure from the enemy's shells, which is not the case in smaller ones, which therefore absolutely require some such secure places to be made.

They are generally made in the gorges of the bastions, and sometimes under the rampart behind  
the

the curtains. As soon as the enemy appears, they set up sheds against the rampart, made with strong timber roofs, covered with thick planks, and earth over them; some houses farthest from the Attac are shored with strong timbers, between every floor, from top to bottom, and the floors covered with straw, wool, dung, fascines, earth, &c. and these, when they are well secured, may either serve for the troops to rest, or for hospitals.

The Powder magazines, above all, require a more special care: tho' they are built bomb-proof, yet when a great number of shells fall upon them, they seldom resist their shock; for which reason, they should be covered with seven or eight feet thick of earth, and a layer of fascines, dung, and strong planks laid over them; but if it should happen, either from their situation or height, that this cannot be done, then a range of strong timbers well fastened together must be laid over the roof, to diminish the shock of the shells; their windows should have no prospect towards the enemy, and no body be permitted to go in or out of the doors, but at such times as the fire of the enemy is slackened.

When there are no powder magazines in a Town, or such as have not been made use of, it is a very troublesome and difficult task to preserve the powder from accidents; all that can be done in such cases is, to divide it into several parcels, and to place them in cellars and holes made under the rampart, at some distance from each other, and to cover them with planks and fascines, having dung or earth laid over them.

The shells not only demolish the buildings upon which they fall, but likewise generally set fire to them;



them; to prevent this, a great number of casks should be placed in the streets, and the soldiers and inhabitants, being divided into several companies, a particular quarter allotted to each of them for extinguishing any fire which may happen there; by this means all confusion will be prevented, and every part of the Town readily secured, in case of an accident. The pavements in all the streets must likewise be taken up, and dung laid there, to prevent, as far as may be, farther damage and disorder from the bursting of the shells.

*The DEFENCE from the Investiture to the Attac of the COVERT-WAY.*

THE Place being invested, and the Besiegers having begun the Line of circumvallation, the Governor should fire at first, either with his small pieces only, or with the great ones half loaded, to deceive the enemy, who imagining themselves out of the reach of cannon, will advance and pitch their camp nearer the Town, which they shall have no sooner done, but the garrison is to give them a full discharge from their great guns, to oblige them to decamp once more, and remove to a farther distance.

If the country about the Place is divided by rivers or marshes, as it generally happens, some quarters of the camp will be separated from the rest; in which case a Governor should endeavour to fall upon some part with great precaution, for fear of the party's being cut off by the enemy's horse; for the loss of such a part of his garrison, at the beginning of the Siege, might be of bad consequence.

As it is of importance to the Besieged, to know  
on

on which side of the Place the Besiegers intend to make their Attacs, no means should be neglected to discover it. The magazine of materials, if it can be found out, may perhaps direct them in this particular; for it is to be presumed, that the enemy will place them as near the opening of the Trenches as they possibly can; and therefore the Besieged should watch every night on that side, for the time of opening the Trenches, to be ready for firing briskly upon the workmen, while they are yet uncovered, which will very much retard the work.

So soon as it is known which side the enemy intend to attac, retrenchments should immediately be made in the bastions and ravelin that are to be attack, and not wait till the enemy comes too near, for then the fire of the cannon and mortars becomes so brisk, that it will hardly be possible to carry on these works; besides, the Besieged will then have other works on their hands, so as not to think on these.

During the time that the line is constructing, the enemy's Engineers will omit no opportunity to get an exact knowledge of the Place, and the ground round about it, to form their plan of the Attacs, and which they will undoubtedly make upon the weakest side, if they can come at the knowledge of it. To prevent this, the Governor should send 2 or 300 men every night, as soon as the Town is invested, to that side which he knows to be weakest, with orders to lie upon their faces, in the form of a semi-circle, whose diameter is, as it were, the palissades of the covert-way; these men should be divided into small bodies, of four or six men each, and distributed at about twenty  
or

or thirty paces distance from each other, so as to occupy a large spot of ground.

A signal being agreed on, to give notice when any body passes between them, they should remain in this posture, and keep silence till day; if any body happens to pass by, whoever sees or hears them rises and gives the signal to the rest, who are to do the same; then all advancing to the covert-way, those who passed are taken as it were in a net, without any possibility of relief from their escorte, who will hardly attempt to rescue them from the hands of 2 or 300 men protected by the fire from the covert-way.

If those who are thus reconnoitring, instead of passing through the intervals, should fall in with some of these parties, and endeavour to get off, they must be fired upon; in which case, it will be difficult for them to escape either being killed or taken prisoners. If this precaution be rightly taken, it will not be an easy affair for the Besiegers to get a true knowledge of the Fortification by reconnoitring.

Another precaution the Governor should take, is to send every night, from the time the Place is invested, several small parties, of ten or twelve men, commanded by a serjeant, with orders to lay on their faces, all round the skirt of the glacis, to keep strict silence, and listen with great attention to whatever passes.

What precaution soever the enemy may think proper to use, to conceal from the Besieged the time and place of opening the Trenches, it is hardly possible but the great motion, which they will be obliged to make about that time, must either be heard or perceived by those placed in the covert-

L

way,

way, who may even venture to advance somewhat nearer the enemy, observing silence, and great caution not to be surprized by the parties which the enemy send out on that side to observe that no one approach too near to disturb their workmen.

The place of the Attacs being known, the great pieces of ordnance are mounted on the rampart of the Town to fire *en Barbet*, and the small ones on the covert-way and other outworks, from whence they are to fire with all possible diligence; and to assist their aim, fire-balls are thrown from the mortars into the Trenches, to discover the workmen and their guards; in the moment of opening the Trenches, the greatest fire should be made upon the enemy as yet uncovered, and consequently most exposed.

The guns may continue to fire *en Barbet*, till such time as the Besiegers have erected their Batteries, which is commonly after the second or third night of the Trenches being opened, but it will hardly be possible to keep them in that position long; afterwards, the Besiegers fire being grown so much superior, that the guns would soon be dismounted, and therefore they must from thenceforwards be pointed through embrasures. The mortars and howitzes should not be idle all the while the enemy are erecting their Batteries, but should throw shells into the Trenches, and towards those places where the enemy are most busy; in short, the best use is to be made of the Artillery before the Enemy are in a condition to silence them.

When the Enemy make a false Attac, it must be endeavoured to find out the real one, and to use the utmost diligence in making good retrenchments in



in the outworks and in the bastions ; but as those new-made works are easily destroyed, it had been much better to have made them in time of peace, that the earth may have time to settle ; by which means they will be much stronger and firmer.

A Governor who understands Fortification as he ought, may easily judge which part of his place is weakest, therefore most liable to be attack, and consequently he should provide for its Defence in the best manner, by retrenchments and outworks, such as he shall think proper.

The Artillery should be disposed in such a manner as to enfilade the Approaches if possible, and fire continually upon the workmen at the head of the Trenches to retard the works. But when the batteries of the Besiegers are once in a condition to return the compliment, it will be difficult for the Besieged to maintain theirs, or prevent them from being destroyed ; the ricochet batteries will enfilade the faces of the work opposite to the Attack, from one end to the other ; neither will the traverses which are made from distance to distance, be any effectual security against them, the shot falling in one place will bound over the next traverse into another.

It would by no means be proper to fire with cannon at the Besiegers batteries, who being superior in number would soon destroy those of the Besieged, and consequently render the guns useless for the remainder of the Siege ; instead of which, so soon as the enemy have made a battery to dismount the guns of the Besieged, they should be removed to some other place more secure, which may probably lead the Besiegers into a belief that they have dismounted them ; and so soon as

they have made another battery to dismount them a second time, they must be brought back to the first place or some other, where they may be out of danger of being dismounted. This way of shifting the guns from place to place, whenever they are in danger of being dismounted, will give the enemy great trouble, and make them lose much time, which is all that is wanted or can be expected.

As mortars may be placed in any work without the enemy's knowledge, they may be used to very good purpose to destroy their batteries, especially those for battering in breach, or to dismount the guns in the flanks; for the distance being so very short, the bombardier must be very unskilful not to throw almost every shell upon them.

The best method of firing for the Batteries of the Besieged is not in salvo's, or all at a time, for the Besiegers place centries in the Trenches to look out and observe which way the guns are pointed, and give notice accordingly to those who are in danger, that they may cover themselves whilst the rest continue to work; but as this can only be done when there is an interval between the firings, whereas if the guns continue firing, though by single pieces only, yet so as to leave no intermission, and shells are thrown at the same time; the Besiegers centries will not so readily venture to look out, and make their Observations which way the guns are pointed; by which means the workmen will work in fear.

#### Of SALLIES.

SALLIES, when made with due precaution and judgment, are one of the principal means to lengthen a Siege; whereas, when they are made without

without sufficient care, or on unseasonable occasions, they rather advance than retard the taking the Place; for which reason the utmost precaution should be used in the execution, as well as great judgment in the choice of time and opportunities.

Sallies are proper when a Garrison is numerous, or the Army of the Besiegers weak; for in such cases the keeping off the enemy from the Place as long as possible, may either dispirit them, or retard the Siege to such a degree, that they may be obliged to raise it, if the season is far advanced, and the weather grows bad.

Sallies are also proper to be made when the Fortification is bad, or the garrison ill-provided with ammunition and provision; it is best, in those cases, to keep the enemy at a distance as long as possible, to make the better terms with them, lest coming too near the Place, and discovering either the wants of the garrison, or the defect of the Fortification, they may have a chance to be made prisoners of war.

On the contrary, when a Place is well fortified and provided with every thing, Sallies are not so proper to be made, as the Garrison may defend themselves with greater advantage behind the works than in the open field; and what precaution soever may be taken to succeed, yet some men must be lost, and the Governor may be deprived of a sufficient number to sustain an assault, or to defend the works so well as they ought to be.

Sallies are dangerous when the enemy is at too great a distance, they may cut them off from the Town with their horse; but when their Approaches are advanced between the second and third Parallels, then is the time for the garrison to sally with-

out much danger, the covert-way being at hand, from whence they are protected; they may even sally whilst the second Parallel is making, though with great caution not to be intercepted by the enemy.

But the most favourable opportunity for sallying is after the third Parallel is begun, and before it is finished; at that time the enemy can have but a small number of men at hand to sustain the workmen, who may easily be driven back, and their work destroy'd.

It is to be observed in general, that the most favourable time for sallying is when the works, which are to contain the guard of the Trenches, are imperfect, that is, before the second or third Parallels are finished, or the Places of arms between these Parallels are in a condition of receiving a sufficient number of troops to protect the workmen at the head of the Trenches. There are few actions in the whole Art of war, that require greater diligence, courage, and conduct than this; by diligence and courage the enemy are surprized and put in disorder or confusion, and oft obliged to abandon their works, which when once destroyed they can hardly ever regain, and re-establish; and by good conduct the enemy's own works may be turned against them; and when all the mischief that can be done is effected, a good and safe retreat is made; in short, good conduct secures from all the dangers which attends a contrary one.

Sallies may be made, either with a small or great number of men, that is, with ten or twelve men only, or with six, eight, or ten thousand; the intent of great Sallies should be to destroy a considerable part of the enemy's works, and thereby oblige



oblige them to repeat their labour to re-establish them, to nail up their guns; to retake some post which had been lost; and lastly, to obstruct and retard the enemy's works so much as possible.

As to small Sallies, they serve to interrupt frequently the workmen at the head of the Trenches, who are ever ready to run away upon the least alarm, desiring no better pretence to leave their work; and as this is usually done in the dark, most of them will get away if they can, and the rest require some time to be brought back: if the enemy, after several alarms grow secure, and take no notice of them, they should be followed by a more considerable one, well supported, which coming unexpected, will not fail having a good effect.

The best time for large Sallies is about two in the morning, as the troops being then much fatigued and sleepy, are less capable of making any considerable resistance, especially against a vigorous and well-conducted Sally; and if it should happen to rain so hard, as the guard of the Trenches should not be able to make use of their fire-arms, the conjuncture would be too favourable to be neglected; in short, no opportunity should escape a sagacious Governor to surprize the enemy, Sallies seldom or ever succeed in any other case.

Mr. *Vauban* would have the following Order observed in large Sallies; there should be a detachment of 90 men drawn up, so as to have 30 men in front and three deep; to these are added a fourth rank of 30 grenadiers; the three first ranks should be armed with breast-plates, and for weapons, a sword and pistol at their sides, and a partizan or long iron-fork with a hook in their hands; this detachment should be followed by another of

180 men, thirty in front and six deep; the first rank of which to be armed as the former, and the rest as usual; after these 200 workmen are to follow with proper tools to demolish the enemy's works, some with combustibles and fire to burn what can no otherways be destroy'd, and some with long nails and hammers to nail up the cannon if an opportunity offers.

There should be another detachment of 3 or 400 men ordered to support the first in case of any attac from the Besiegers, and to secure their retreat; these last are to follow the former in a slow pace as far as the head of the Trenches, where they halt, and stand ready to assist the others upon the first occasion.

So soon as the guard of the Trenches are overthrown, the workmen fall to demolishing the works as fast as possible, and if these troops can penetrate so far as the enemy's batteries, they nail up their cannon: when they have done all the mischief that the time will permit, they retreat in good order; and if the enemy should pursue them to the works of the place; then so soon as the Sally is got within the covert-way, all the cannon from the place should fire briskly upon them, whilst the troops in the covert-way and adjacent out-works, pour in their small shot amongst them, this will soon oblige them to retire, with considerable loss.

In all actions performed by night, the troops should have a mark to know one another, a white paper or handkerchief in their hats.

The troops designed for a Sally are drawn up in the covert-way, or in the ditch if it is dry, or else in some of the out-works, from whence they may be able to march out in great order.

If there is more than one attac, as there generally are, then Sallies may be made upon each of them at the same time, that the enemy finding themselves suddenly attacked in several places at once, added to the terror heightened by the darkness of the night, may throw their troops into confusion, which the assailants observing, are to make their best advantage of: It would not be improper if some small parties were sent out several different ways, making a great noise to draw all the attention of the troops towards them, and then the great Sallies to fall on suddenly some other way, which seldom fails of having a good effect.

When the Besiegers works are yet far off, two detachments of horse are ordered, besides the foot, on the right and left, to support the Sallies, and prevent the enemy's horse from cutting off their retreat; but after the third parallel is finished, the sallies are then made with foot only, and should be strong and frequent, provided the garrison is numerous enough to dispute every part of the ground.

So soon as the troops are retired into the covert-way, fire-balls should be thrown into the Approaches, to discover the workmen, as they are then busy in repairing the works, which were destroyed, and are, for the most part, uncovered, the fire of the place, well served, at that time, may do them great mischief, and retard the Siege considerably.

The small Sallies, whose object are to disturb the workmen frequently, without being in a condition to do them much hurt, are made by parties of ten, fifteen, or twenty stout men only, as said before, who advance in great silence to the head of the  
Trenches,

Trenches, jump suddenly into them, making a great noise, and throwing some hand grenades, this done they retire, making the best of their way, for fear their small number should be discovered.

*Of the LINE of COUNTER-APPROACH.*

THE Line of *Counter-approach* is a kind of Trench, of 12 or 15 feet wide, which the Besieged make from the covert-way, such  
 PL. XXI. as a, a, at the right and left of the attacks, to enfilade the Trenches of the Besiegers.

This Line has been neglected of late, not so much on account of its lengthening the Siege, as from the indolence and inactivity of the Governors, who think it sufficient to secure their reputation if they keep a brisk firing with their great and small arms, and make a few sallies; and so soon as the covert-way is taken capitulate, to have the honours of war allowed them.

As this work is intended for those brave officers who are desirous to use their utmost endeavours to defend the Place, for their sake I shall explain the use of these kind of Lines.

They are to be made in such a manner, as to be enfiladed by some of the works belonging to the Town, and produced so far as to enfilade some part of the Trenches.

They may begin either at the salient angles of the covert-way, before the adjacent ravelins to the Attac, or from the place of arms, as represented here, next to the ravelins; small guns should be placed next to them, to defend their approach by the enemy, and large ones upon the works that see in them to enfilade them, in case the enemy should attempt



attempt to make a lodgment, after they have got possession.

But it would be much better to carry a gallery underneath, to blow them up so soon as they are no longer serviceable. The enemy will endeavour to cover their works from being enfiladed by these Lines, by making frequent turnings, which cannot be done without loss of time, and will carry Trenches so as to get possession of them; but a few small guns placed there will make their Approach dangerous. Another advantage of these Lines is, that they render the enemy's horse useless against the Sallies of the Town, and even when they have covered themselves from the enfilades of them, others may be made farther off, to enfilade them again.

Light field-pieces may be placed in these Lines, to enfilade their Trenches, which when near, grape-shot must be used, by which the Besiegers will be obliged either to attac the Lines sword in hand, or to make their Trenches deeper than ordinary; in either case the approaches will be retarded; but when the Besiegers come once so near as that they may storm these Lines, the pieces must be withdrawn for fear of being taken.

It may be observed that all works in general, which oblige the Besiegers to open their Trenches at a distance or enfilade them, are very useful in retarding the Siege, which is all that is wanted or can be expected.

#### DEFENCE of the COUNTERSCARP.

**T**HE enemy being arrived at the foot of the glacis, they must be disturbed so oft as possible in their works, by firing at them from the covert-

covert-way, and from all the nearest adjacent works; by fallies, of a good number of men, to make them quit their works, to destroy them; and many fire-balls should be thrown all night, by which they will not be able to stir, without being seen and exposed to the fire of the Place.

If there are any works before the glacis, such as detached redouts or arrows, the Besiegers will endeavour to get possession of them, either by sword in hand, or by saps; to prevent their being taken sword in hand, they should be well palissaded; and the saps may be retarded, by throwing a great number of grenades and other fire-works into them, also by sudden fallies, and retreating quickly; and there should be some with sap-hooks to overturn their gabions, others to burn them with some combustible; in short, all means should be used, that art or cunning can devise, or time and situation allow.

If there are any detached redouts at a small distance from the covert-way, the Besiegers will carry their saps round them, to take them by the gorge; those who defend such works, after they have made all the defence possible, should take care to retire betimes, otherwise they will be in danger of being taken.

The Besieged should never defend any works with too much obstinacy, by which they may lose many men to little purpose, as being always overpowered by a superior number, but on the contrary, to retire in proper time; and so soon as the enemy are fallen to work at their lodgments, to secure their new possession, a sudden and brisk sally should be made, to drive them out, before they have time to settle, and destroy their works; this  
should

should be repeated so oft, as it may be done without too great a loss of men, and may succeed for some time, as being near the covert-way, where sallies may be so well supported from thence, as to make the foremost of the enemy give way, and these never fail to throw the rest into confusion; in the mean time the works are possessed, which were before abandoned; but the Besieged will at last be obliged to give way to superiority, without any hopes of returning; then it is that the Mines, which ought to have been placed under these works, should be sprung; this will not fail to destroy their lodgments only, but themselves likewise, if they are well executed. This may, perhaps, afford the Besieged an opportunity to return once more, whilst the enemy are yet in confusion.

The enemy being now in possession of these out-works, will endeavour to render the caponiere, which leads to them, useless, either by enfilading them with their guns, or by rolling stuffed gabions before them; this proceeding of theirs must be opposed by the fire of the great and small arms, by shells, stones and grenades, as by sallies likewise; all which may retard though not stop their course.

At the same time that a Place is fortified, a gallery with stone or brick should be made all round the Counterscarp of the covert-way; and from this others under the saliant angles of the glacis and the places of arms in the re-entring angles, nearly as far as the glacis reaches: this may be done at an easy rate. For instead of making counterforts, arches are made as at *Bergen-op-zoom*, which, I have shewn in my practical fortification, is very little more expensive, and when the Place is attacked,  
branches

branches are carried to the right and left, so as to make mines under every part of the glacis ; and as fast as some are sprung others are made ready ; this will oblige the Besiegers to proceed with great caution, and to secure their works above-ground, must carry on galleries and make also mines underground, whereby the Siege will be considerably retarded.

It is in this place, says the famous miner Mr. *de Valliere*, where the greatest use of mines may be made ; for if they are properly contrived, every part of the glacis may be blown up several times ; and if this be well executed, will reduce the Besiegers either to abandon the Siege, or if they are bent upon the taking the Place, make them pay dear for it.

The manner how these mines are to be placed and executed, will be shewn hereafter in the treatise of mines.

The enemy being come near the covert-way, will prepare to attac it, either by sword in hand, or by means of saps, which they carry along the ridge of the glacis. To prevent the covert-way from being insulted sword in hand, a double row of palissades should be placed in it, at four or five feet distance from one another, with crows-feet placed between and before them ; likewise sacks full of powder, to set on fire when the ground can no longer be maintained ; coffers of three feet long and a foot square are also placed three feet underground, filled with shells and grenades.

In the mean time, frequent sallies should be made, either to destroy their materials, if possible, or to retard their Approaches. But if they continue their Approaches, they should be opposed  
with



with vigour and force ; till overpowered at last by superior numbers, it will then be proper to retire behind the traverses at the saliant angles, and into the redouts of the places of arms, making, at the same time, a general discharge of great and small arms, from all the works facing the attac, and setting fire to the sacks of powder, coffers and shells, which were placed under the glacis.

If this should happen to throw the enemy into much disorder, they must be suddenly attack to drive them out ; and if that fails, fired upon from all the adjacent works.

This kind of Defence having been continued till the enemy is so well established in the covert-way, as that it is impossible to drive them any more out of it, the Mines are sprung, to destroy their lodgements.

The Besiegers having got possession of the covert-way, will prepare to attack the redouts in the places of arms ; but if they have revetements, and their ditch a good row of palissades in the middle, they will give the enemy no little trouble, and oblige them to make their Attacks by saps and Mines ; this the Defenders will oppose, with all that art and stratagem can invent ; and when they have done every thing in their power, and the enemy are near enough, and just ready to storm, they will at last retire, setting fire to the Mines, to blow up the redouts, together with the works near them. Great care must be taken, in the springing Mines in the covert-way, that they may not throw the Counterscarp into the ditch, which would save the Besiegers the trouble to make a descent.

If the ditch of the Place is wet, small Floats are made, with parapets on each side, musket-proof,

proof, which serve to bring off the troops from the redouts, and other out-works, when they can no longer be defended, as also to disturb the enemy in the covert-way, which they approach in the dark, give a discharge into the works, throw grenades in them, and overturn the gabions with sap-hooks and then retire, to let the fire of the opposite works act, where the workmen being uncovered, will do much damage and retard the work. When the descent into the ditch is making, the Besieged approach near the opening into the ditch by means of these Floats, set fire to the fascines which are above water, and fire upon the workmen: and lastly, to destroy the enemy's miners who are sent to lodge in the breach.

It is to be expected that the enemy will give several false alarms, as if they intend to assault the covert-way, to put the Besiegers upon springing their Mines, which should however not be done till it can be deferred no longer; then those most advanced are fired first, so as not to render the others useless; and if the Besiegers make Mines likewise, they should be searched for, either to destroy or render them useless; but if that is not to be done without the hazard of being discovered or blown up, it would not be improper to make a shew of an intended sally, before the Mines are sprung, to draw great numbers of the enemy towards the place and increase their effect.

If the garrison is too weak to defend the covert-way with open force, a small party left in the salient angles only, with orders to give a general discharge, and retire so soon as the enemy are advanced within some paces of the palissades, setting fire to the coffers, shells and grenades buried under the glacis; and

and so soon as the enemy are got within the covert-way, a general discharge is to be made with all the fire-arms from every part of the opposite works, and immediately after a strong sally should be made from the places of arms to recover the covert-way; and this Defence is to be continued till such time as the enemy have quite finished their lodgments.

If the Besiegers approach the covert-way by saps, and make no galleries for Mines, sallies are sometimes feigned, and sometimes executed; shells and grenades are thrown to retard the work, and when their lodgments on the ridge of the glacis are made and filled with troops, their Batteries finished and ready to fire, the Mines are sprung, which if well executed, ought to blow up both their lodgments and Batteries at once; but if the enemy have any galleries by which they find out the mines, it will be necessary to destroy their cavaliers by guns placed in the works opposite to them, and by shells and stones thrown into them; and a general sally should be made on all their works at once.

*The DEFENCE of the PASSAGE over the Ditch  
before the Ravelin.*

THE Besiegers having got possession of the covert-way, and perfected their lodgments in it, will fall to work at their Batteries for making Breach, and at the descent of the ditch; this work must be opposed by the fire of both great and small arms; if the ditch is dry, ladders may be set against the counterſcarp, and from them grenades thrown into the enemy's lodgments, while some with sap-

M

hooks

hooks pull down the gabions, sand-bags, &c. to uncover and expose the workmen to the fire of the Place. Mines may be used here with great advantage, for they furnish various means to fatigue the Besiegers and obstruct their work; to make them lose likewise much time and many men.

Mines should particularly be placed under the Batteries of the Besiegers to blow them up, which may be done several times, if the ground permits, to make several under one another \*, by which the enemy will lose much time in the repairing them; and if these mines are rightly placed, they may throw the guns every time into the ditch, by which they will be obliged to bring others from distant places, and will never be secure till they are masters under-ground; and while they are repairing their works, the retrenchments in the ravelin and bastions may be finished, if not done before.

Whilst the enemy are preparing their Batteries to make Breach, they work at the descent into the ditch at the same time; which, when made under-ground, the miners should endeavour to oppose them; if the ditch is dry, small detachments of five or six men may be placed near the counter-scarp, to watch the moment that the enemy break

\* At the Siege of *Turin*, in 1706, the Besieged blew up the Batteries of the Besiegers which were on the covert-way several times; by this, and other stratagems, they gave time to prince *Eugene* to come up, and drive the *French* out of their Lines, and relieved the Town.

Mr. *Belidor* made three Mines at *La Ferre* in 1729, one under another, under the Batteries which were to make Breach in the Lunets, at the side of the ravelin, with which we blew up these Batteries three several times, and every time tumbled the guns into the ditch.

through



through the revetement of the ditch to fire into the gallery, and then retire on each side of the opening to load their arms again; this may be repeated several times, whereby the sappers will either be killed or obliged to retire, and which must retard the works; fire-balls and grenades may likewise be thrown into this opening with good success on this occasion.

Besides what has been already mentioned concerning the Defence of a dry ditch, caponiers are made in the entrance near the ditch of the Place; that is, a kind of parapet sloping like a glacis cross the entrance of the ditch before the ravelin, behind which a few small guns are placed, whose fire, together with that of the opposite faces of the bastions, well directed, will increase the Defence considerably. These caponiers serve also to fall from thence, and to fall on the workmen in the ditch, which may be done with safety, by reason of the secure retreat.

It is certain that the passage over a dry ditch may be disputed with great advantage for a considerable time, by frequent sallies, Mines and fire-works; whereas that over a wet one can only be opposed by the fire of the great and small guns, and burning the fascines above water; or if the water has a strong current, by opening some sluices on a sudden to carry away their fascines, and whatever else is used to make the passage. But as in time the Besiegers will surmount all those obstacles by their superiority, we shall suppose that they have carried their works quite up to the Breach.

## DEFENCE of the RAVELIN.

**W**HILE the passage over the ditch is making, all proper precautions are taken to oppose the enemy, and to defend the Breach, with all the stratagems and force that art and opportunity can suggest; guns are placed every where from whence the Breach may be seen; the retrenchments in the ravelin are put in good condition; a row of palissades are placed along the middle of the ditch, from one end to the other, with a sally-port at each end, as likewise another on the outward slope of the parapet, in an horizontal manner, rather inclining a little with the points downwards, so that the grenades thrown upon them may roll down into the ditch. The palissades in the ditch serve as a kind of barrier for the Besieged to retire behind, when hard pressed, and for keeping troops there in readiness, either to support those who defend the Breach, or secure their retreat; as likewise to prevent the retrenchment from being insulted sword in hand.

If the garrison is sufficiently strong, two or three retrenchments may be made, with parapets of about 12 or 15 feet thick, a rampart of 15, and a ditch of 18 or 20 wide; each of the ditches should be palissaded, as well as each parapet, in the same manner as was directed for the first.

As the ravelins are very spacious, a Governor, who has every thing necessary for a good Defence, should not content himself with the bare works of the Place, nor with one single retrenchment in each work, but on the contrary, should make so many as the works will admit of; which being  
well

well made, and secured from being insulted sword in hand, will enable a skilful commander to defend every inch of the work, with great advantage to himself, and to the no less detriment of the Besiegers.

If the enemy intend to take the ravelin by storm, and their troops are ready to mount the Breach, a great quantity of all kinds of combustibles are thrown at the foot of the Breach, to be fired, and constantly supplied with fuel, when they are mounting the Breach; a great number of grenades are thrown down amongst them, sacks filled with powder, glass or earthen bottles filled with powder, and burning matches twisted round them, thundering barrels, crows-feet, harrows, and large timbers with long iron spikes, fastened with chains, so as not to be removed by them, as also shells so confined as not to roll out of the Breach; a great quantity of loose powder is also scattered about, and fire set to it, at the approach of the enemy; in short, all kinds of fire-works and engines made for military use, should be employed to retard the loss of the work. This being well executed, and fire-arms, both great and small, well served, together with the mortars for throwing shells and stones, will do them infinite damage, and retard the taking of the work for several days; as was the case at the Siege of *Turin*.

When all the Defence is exhausted, and the enemy got at last possession of the Breach, the Mines are fired, to destroy, if possible, all those in the Breach, and overset all their works in it; which being perceived by the Besieged, they must return immediately, and clear the Breach, so as to render it impracticable. Several Mines should be made one under another, if the ground will allow

of them, that the Breach may be destroyed several times, which will be a means to dishearten the enemy's troops, and put them quite out of patience.

If they should attempt to get possession of the Breach by means of saps, they must be continually harraſſed with fire-works of all kinds; grenades, even shells, may be rolled down amongst them, and they should frequently be suddenly fallen upon, by a party of ten or twelve men, to drive them out and destroy their works; and sometimes small Mines may be sprung; and lastly, when all endeavours, either of force or stratagem, are overcome by the obstinacy and superiority of the Besiegers, as the last resource of the Besieged, a great Mine should be sprung, which being well executed, will destroy the Breach in such a manner as to make it absolutely impracticable.

But suppose, the Besiegers are masters of the Breach, and their lodgments in it so well secured, as to make it impossible for the Besieged to drive them out, all possible precautions are taken to perfect the retrenchments in the ravelin; the Besiegers will therefore be obliged to make use either of Mines or guns to destroy them. In the first case, the miners cannot approach the parapet before the palissades in the ditch are broke; which when attempted by the enemy, they must be briskly fired upon, and a great quantity of grenades thrown in amongst them, to give them some trouble in doing it; however, as it must be done at last, we shall suppose that they have accomplished it one way or other; so soon as they are broke, great quantities of fire-works, with all kinds of combustibles, are  
thrown



thrown into the ditch, by which means the Approach will be retarded so long as the fire lasts.

In the mean time, a gallery should be made from the ditch behind the first retrenchment, and carried under its parapet to lie in wait there for the enemy's miners, and oppose their making of Mines to blow up the first retrenchment; and so many Mines should be made by the Besieged as may blow up the whole retrenchment, when it can be defended no longer.

When a Governor is resolved on a long Defence, and is provided with every necessary for that purpose, numberless stratagems may be used, both above and under ground, to fatigue the enemy, and make them lose more men and time than the conquest is worth.

If the Besiegers are put to the necessity of making Breach in these retrenchments with their cannon, it will cost them great time and trouble to make a passage for their guns through the ditch, and to bring them up the Breach, as also to erect a Battery in the ravelin, under the near fire of the retrenchment, which cannot be silenced till that Battery is made; and they may likewise be all that time opposed by sudden sallies, Mines, grenades, and all kinds of fire-works, and at last when their Battery is finished, and ready to fire, it may be blown up.

Whatever has been said in regard to the Defence of the first retrenchment, may be put in practice in the Defence of the second and third likewise, if there are so many; so that a ravelin or any other considerable out-work, when defended as it may be, will stop the enemy for a considerable time.

This has seldom been the case, if there is one retrenchment in a work, it is generally thought sufficient; but it happens oftener that there is none at all; so that one may suppose, a Defence like that we have been explaining is only chimerical, if the Sieges of *Vienna* and *Candy*, both by the *Turks*, were not instances of the contrary, where there was hardly an inch of ground either within or without those two towns, as far as the extremities of the glacis, and even beyond them, but what was retrenched and countermined.

*The DEFENCE of the PASSAGE over the ditch before  
the BASTION.*

**W**HILIST the enemy are carrying on the Attacs of the ravelin, they work at the descent and passage over the ditch before the bastion at the same time; all that has been said with regard to the defence of the ditch before the ravelin, may be executed in the defence of this: to which may be added, that the caponier leading from the middle of the curtain to the ravelin, when the ditch is dry, will be of great use to fire upon the enemy in their passage, and to sally from thence, to destroy their works: a row of palissades may be placed in the middle of the ditch, before and parallel to the faces, and at each end of them, opposite to the flanks, caponiers or breast-works may be made something lower than those before, and so as to flank the palissades, behind which small guns may be placed loaded with grape-shot to defend the palissades.

All caponiers or retrenchments made in the ditch, should be covered with strong planks, to secure those placed there from the grenades and other fireworks, as likewise stones thrown by the enemy placed near the opposite counterscarp.

But as this covering may be set a fire, the planks must be covered with some earth or dung, or with fresh ox-hides.

These lodgments in the ditch should also be countermined, if it may be done, or else coffers and shells sunk in them to blow up the enemy when the works can be no longer defended; the horse may be used with safety in the sallies from hence, having the rest of the ditch to retire into.

If the ditch is wet, and has tenailles, the fire from them will very much obstruct the passage; and the floats or boats mentioned before, may approach the Besiegers works in the dark, pull down their parapets of fascines with their long iron hooks and forks, and thereby expose the workmen to the fire from the bastions, curtains and flanks; and when their works are raised above water, a quantity of fire-balls and other fire-works are thrown upon the fascines to burn them.

If there are any dykes or sluices, they may be opened so soon as the work is raised to any height, that the rapidity of the current arising from thence may overset and carry away the works. But it must be observed, that if there is a sluice to let in the water it should never be opened till the last extremity; for if once the ditch is filled all the stratagems, which a dry ditch can afford, are over; on the contrary, when all the defence is exhausted, and the Besiegers are mounting the Breach, if then the water is let in, it will put them into such confusion,  
that

that they may be easily repulsed with the loss of all those that have passed the ditch, provided the water can be raised suddenly to a great height.

When *Landau* was besieged by the *Imperialists*, Mr. *de Valliere* advised the Governor not to open the sluices till the assault was made, and by not taking this advice, the Place was taken much sooner than it would have been, had the ditch not been filled so soon.

Mr. *Belidor* in his *Architecture Hydrauliques*, has shewn, that if proper sluices were built under the bridges, and at the ends of the ditches, where a sufficient quantity of water can be had, how one ditch may be kept full of water whilst all the others are dry, and how to fill or empty the ditches as occasion requires. If this scheme was used, it would be next to impossible to take the Place by open force, at least not without losing more men, and be at greater expences than the Place is worth. The defence before the bastion is certainly the most shining part of a prudent Governor; without exposing the garrison to be cut off, or even going out of their works, he may put all stratagems in practice to destroy the enemy's works and workmen many times; while, on the contrary, the enemy can oppose him but with a small number, and which can only be supported from places at a great distance.

#### *The DEFENCE of the BASTION.*

THE Besiegers having finished the passage over the ditch, and the Breach ready for an assault, they must be opposed by the stoutest men of the garrison; some of them should be armed with breast-



breast-plates on this occasion, and long pikes in their hands to defend themselves, and to repel the enemy if possible. It is supposed that a Governor, who is resolved to defend the Breach in the bastion, has made one or more retrenchments in it, and placed a row of palisades in the middle of the ditches before them; and if these retrenchments are made with faces and flanks parallel to those of the bastion, Mr. *Vauban* would have rows of palisades cross the rampart, for the defenders to retire behind when drove back by the assailants; not only small light guns should be placed in these retrenchments but likewise mortars to sling shells and stones, by which, when the Besiegers are lodged in the Breach, they may be so harrassed as to be unable to keep that post. Mines should likewise be made under these works, so that when the Breach is lost, the Besiegers cannot come underground to blow them up, and to oblige them, if possible, to make a battery in the Breach to batter these retrenchments, which will cost great trouble, and during that time other stratagems may be used to retard the work. The several stratagems mentioned in the defence of the Breach of the ravelin are to be practised here; and when the defenders are obliged to give way to the superior force of their enemy, they should open to the right and left, and retire along the parapets, to leave room for the guns placed in the retrenchment to give a general discharge upon the enemy, which should be done with grape-shot; if this is well executed in proper time, it will surprize, if not drive the enemy back; which being perceived, a vigorous and sudden onset should be made to push them

them down the Breach, if possible, and then to repair it.

Many other stratagems may be used in the defence of the Breach, besides those mentioned ; as for example, water-engines may be placed in the retrenchments with leathern pipes, which would make a kind of an artificial rain, and being directed towards the Breach spoil the enemy's fire-arms, so as to make them useless for the present ; engines may be contrived to fling heavy stones, or large pieces of timber amongst them, or to blow dust or sand in their faces ; in short, a man of invention may find a thousand oddities to stop an enemy upon such occasions.

When *Alexander* the great besieged *Tyre*, the Besieged filled armours with sand, which they heated, and threw them among the Assailants, whilst they were endeavouring to climb the wall ; the sand, thus heated, stuck so to their cloaths that it was impossible to get it off, and burnt them to the very bones.

*Hannibal*, the *Carthaginian*, in a sea engagement, threw pots filled with snakes amongst the enemy ; the pots being broke the snakes run about all over the ships, which terrify'd them to such a degree that he presently conquered them.

Whoever reads of the ancients manner of attacking and defending Places, will find that they were much superior to the moderns in their contrivances ; and since the invention of gun-powder all those engines which were of use before have been entirely neglected ; but I am persuaded that many of them would be as useful now as ever, especially in the defence of Places.

When

When all stratagems are exhausted, and the enemy at last succeed, the Besieged retire and set fire to their Mines, as in the defence of the Ravelin, which being well executed, will destroy the Breach so effectually, as to make it impossible for the Besiegers to lodge in it, as happened at *Maestricht* when it was besieged by King *William*, then Prince of *Orange*, and defended by *Calvo* the *French* Governor; the Besiegers having lodged in the Breach at the saliant angle of the bastion were blown up by a Mine, and the Breach destroyed, so as to render it impracticable to repair. They made another Breach near the angle of the shoulder, and when they had lodged in it, were blown up as before; they then made one near the other angle of the shoulder, where they were served in the same manner; by this means the flower of the Army were destroy'd, and Prince *Conde* coming up with a small Army to relieve the Town, the Siege was raised.

But supposing the Mines should not produce the entire effect that may be expected, they will at least disorder the Besiegers so much, that if they are charged with vigour and suddenly, they may be drove out and the Breach repaired.

If the enemy attempt to lodge in the Breach by means of saps, they must be charged often with small parties of ten or twelve men only; shells, stones, and grenades thrown amongst them, as in the Defence of the ravelin, and when it can be no longer defended, the Mines are sprung. If the ditch is dry, the enemy may be diverted from their design, by Mines carried on underneath the ravelin from the gallery, which serves as a communication betwixt the ravelin and the curtain; so soon as the enemy prepare to assault the bastion, fire is set to these

these Mines to blow up their lodgments in the ravelin, and which being immediately taken possession of by the Besieged, they may fire from thence upon the Besiegers in the Breach of the bastion; this will oblige them to retake those lodgments, and in the mean time the Breach in the bastion may be repaired.

If at the same time another Mine is carried under the Breach of the ravelin, and so successfully sprung, as that the enemy's works there are destroyed, and themselves driven out; they cannot proceed in their attac, till they have taken the ravelin, which cannot be done without great trouble and loss of time, besides dismaying their troops, seeing all their labour lost, and dangers returned: such a master-stroke may not improbably occasion the raising the Siege, or reduce the enemy so low, as to make it easy for the Besieged to relieve the Place.

While the enemy are busy in retaking the ravelin, the Governor should lower the flanks which were ruined, and make new embrasures; they should not be quite opened till the guns are ready to fire; and if the Governor adds another flank within the bastion or Battery higher than the other, he will be in a condition to dismount the enemy's guns opposite to these flanks, having more to oppose them with than they can bring against him.

The enemy having retaken the ravelin, and repaired the disordered passage over the great ditch, as likewise the Breach, will attac the bastion again, which is therefore to be defended with the same force and stratagems as before; and when the Besieged can maintain their ground no longer, retire behind the palissades in the ditch of the retrenchment,



ment, setting fire to their Mines, if there are any left, whilst those within the retrenchment fire with all their might into the Breach with guns and mortars, stones, grenades, and small arms.

The enemy having made themselves masters of the Breach, and finished their lodgments in it, will be obliged to take the palissades and retrenchments with the same trouble and precaution as those in the ravelin; they must therefore be defended in the same manner as those, and this must be continued and repeated till the Besieged are reduced to the last retrenchment, where the Governor having no more ground left to defend, may agree to a capitulation, which, if it is not very advantageous, cannot but be very glorious, both for him and all those who fought under him.

Tho' the usual method is to attac the bastions, yet it has happened that the enemy have attack the curtain, being aware that the bastions were well retrenched, as Prince *Eugene* did at *Lisle*, and therefore the Besieged should prepare against such an attac, by making retrenchments at each end of the curtain, cross the rampart, to flank the Breach, and placing guns in them loaded with grape-shot; they should likewise pierce the walls of the buildings opposite and near the Breach, for loop-holes to fire through, and place troops in all the adjacent places, wherever they can have a view of the enemy in the Breach; as the Inhabitants of *Barcelona* did, where the *French* and *Spaniards* together were driven twice from their lodgments on the rampart, and at last allowed terms of capitulation.

*Of RETRENCHMENTS, and their Figure.*

**R**etrenchments seem to have been much more in use formerly than at present, though it is impossible to tell why they are neglected; they are now used but seldom in any works; the Governors content themselves with defending the works of the Fortification only, without taking any farther trouble to make new ones, whereby the Siege may be lengthened; and it has generally happened of late, that so soon as the Besiegers get masters of the covert-way, the garrisons have capitulated. It is most certain, that for such defences it were superfluous to make any additional works, since the chief of those already made seem of no farther use than to make (as term'd) an honourable capitulation; but if the body of the Place, and the large ditch round it, are to be of no more use than they make of them at present, it would be as well to make only a single rampart, without either bastions or curtain, and a small ditch; this would be saving of expences, and yet produce the same effect.

The intention of this work is to point out such means as may conduce to a long and vigorous defence, it will therefore not be improper to shew the advantages of retrenchments, when they are well constructed and defended by a skillful Governor.

As their parapets are to be somewhat lower than those of the works, in which they are made, they can be seen from no other place than from within the works; so that if the enemy intend to batter them, they must make a passage for their cannon over the ditch and through the Breach, which cannot

cannot be done without trouble and loss of time. Their usefulness consists in this, that they afford a safe retreat to those who defend the Breach, enabling them to resist to the last extremity, without any danger of being made prisoners; whereas, on the contrary, when there are no retrenchments, the troops having nothing to depend on but the mercy of the enemy, grow disheartened, and oft retire so soon as they are vigorously attacked.

When the Besiegers are in possession of the Breach, the guns of the retrenchments loaded with grape-shot, together with their small arms, do very great execution amongst them, and oft drives them out. Nor can they be safe in their lodgments, so long as they are not masters of the retrenchment; for the Besieged may fall from thence whenever they please, fall upon them, and destroy their works.

They likewise obstruct the progress of the enemy's miners, who cannot get at them till the palisades in the ditch are broke, whereas those of the Besieged begin their galleries at the same time as the Attac, and have no more to do but to wait for their opponents, watching which way they come, and, when they are near enough, to destroy them.

This, with what has been already said with regard to their Defence in the ravelin, will sufficiently convince the reader of their usefulness; it remains now to say something of their construction and situation. They may be placed in all kind of works, where there is a sufficient space for them, as in bastions, ravelins, horn and crown-works. Their figures are various, some in the same form of the work itself, others in that of the front of a polygon, that is, with two half bastions and a curtain; and sometimes with one or more retring

N

angles

angles or bendings. *Plate XXI.* represents several kinds.

*The DEFENCE of a HORN or CROWN-WORK.*

**T**HESE kind of works are or ought to be made only for inclosing a suburb, or some spot of ground, which may be advantageous to an enemy, and which falls without the compass of the body of the Place. When they serve to inclose any building, their Defence is exactly the same with that of the body of the Place, with this difference only, that they may be defended to the last extremity without endangering the Place. When the inside is not taken up with any principal buildings, having only magazines, store-houses, or hospitals there, which is generally the case in new-built Places, those buildings must be demolished; and as their insides are very spacious, they may admit of several retrenchments, some of which at least should be made in time of Peace, with revetements, and wet ditches before them; which must be enfiladed by the ravelin, and when the Place is invested, and the Attac made on that side, more may be made. It is certain, that an experienced Governor, who has every thing in plenty for his Defence, may defend a work of this nature a long time, and dispute the inside inch by inch; and when the enemy have got possession of one retrenchment, may drive them out from another, either sallying or blowing them up with Mines.

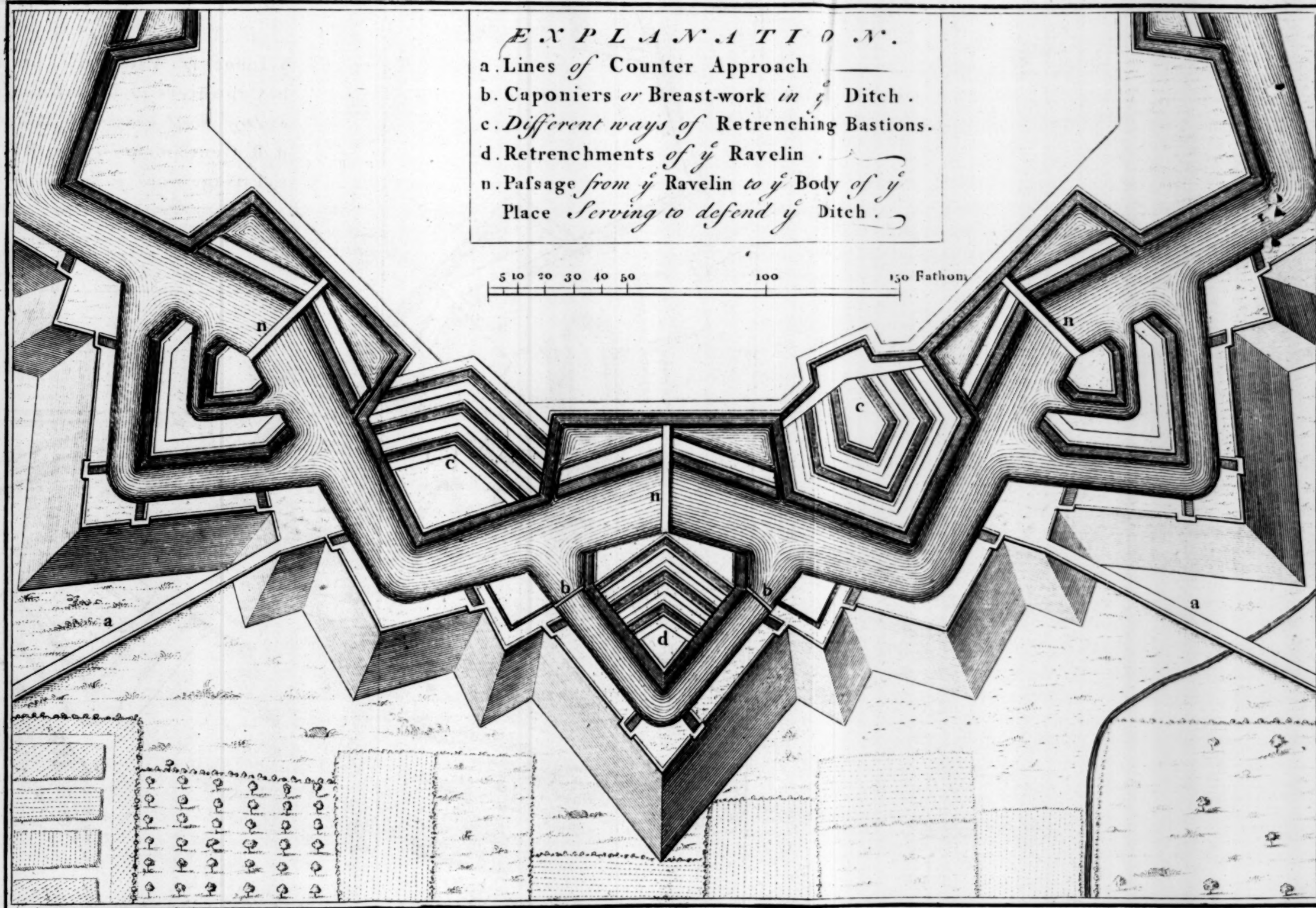
These kind of works have not always made that Defence, which might have been expected from works so considerable, and so expensive in their construction; but, in my opinion, it has rather been  
owing



## EXPLANATION.

- a. Lines of Counter Approach  
 b. Caponiers or Breast-work in <sup>e</sup> Ditch.  
 c. Different ways of Retrenching Bastions.  
 d. Retrenchments of <sup>e</sup> Ravelin.  
 n. Passage from <sup>e</sup> Ravelin to <sup>e</sup> Body of <sup>e</sup> Place Serving to defend <sup>e</sup> Ditch.

5 10 20 30 40 50 100 150 Fathoms



owing to the inabilities of the Governors, or the want of necessaries to defend them, than to any defect of the works.

There is nothing more particular in the Defence of these retrenchments, than those of the ravelin, which I have explained; it is only to be observed, that M. *Vauban* allows no more troops for a horn or crown-work than for a bastion; which is not sufficient for a good Defence; there ought to be at least twice that number, that is, about 2000 men.

As horn and crown-works present but a small front to the Besiegers, and which cannot be seen or defended by any other work, their resistance cannot be very great; but as they are very spacious within, retrenchments upon retrenchments may be made; and if their ditches have one or two rows of palisades, and these works countermined, there is no doubt that the inside of these horn or crown-works may be defended inch by inch to the very last, with all possible advantage. For the Besiegers must make a Breach into every one of the retrenchments, either with cannon or by mines: if they make use of the former, it will cost them much trouble and time to erect the batteries, and bring the cannon over the ditches, where the Besieged are so near, and can sally upon them, nail up their cannon almost when they please, and at last blow the batteries up by mines. If they make the Breaches by mines, they must carry their galleries under the ditches and palisades; and as the Besieged's miners lay in wait, may destroy them whenever they come near; all that the Besiegers can do, is to make Breaches in the branches as well as in the front, and endeavour to destroy the retrenchments with shells, and annoy

the defenders with stones ; this will require much time and the loss of a great number of men. I am persuaded that if these works were defended in the manner they might, it would require at least a month to take any one of them.

*The DEFENCE of a SECOND DITCH and a SECOND  
COVERT-WAY.*

**S**UPPOSE that the second ditch is full of water, so high as to be even with the foot of the first glacis ; they should at least be constructed in this manner, when the nature of the ground will admit of it. The Defence of the second covert-way, and the lunets, are exactly the same as that of the first, when there is but one, and the ravelins. As the fire from the covert-way is grazing, and may be accompanied with stones, shells, and grenades, the passage over the second ditch, as also the making the lodgments on the first glacis, will meet with great difficulties ; and whenever the enemy attempt it, which cannot be done till about the middle of the glacis, for want of sufficient depth of earth above the level of the water, sallies are to be made to drive them back ; which may be done with success, the first covert-way being so near, and the enemy not having it in their power to support their workmen, but by a few men only.

The enemy having made their lodgments on the first glacis, near the first covert-way, they must be disturbed so much as possible above ground ; and when that can be no longer done, without visible danger to the Besieged, they spring their Mines or coffers, if they have any. As to the rest of the  
Defence,



Defence, it is the same as if there were no second covert-way or second ditch.

If the second ditch has sluices so as to keep it dry, or let the water in upon occasion, it should be kept dry till the Besiegers have taken the second covert-way, and have made their passages over the ditch; because sallies may be made with more ease and security: but so soon as the Besiegers begin their lodgments upon the first glacis, then the water is let in, which will probably carry away the works made thro' the ditch, if there is a sufficient current; or at least they will be obliged to raise them; and if the water can be raised so high as to overflow the greatest part of the first glacis, the Besiegers have no other means left, than either to destroy the sluices, or to cut a drain cross the second covert-way and glacis; but whilst either is doing, the Besieged are not to be idle spectators, but on the contrary, use all the stratagems that art and the situation can afford to retard it: if there are good stone redouts in the places of arms, and coffers full of powder lodged in the glacis, as likewise mines as low as can be, the defence may be carried on a great while, and nothing but stones and shells can hurt them; these and many other stratagems, should be used to retard the taking any of the works; for if every part of a Place is defended in the best manner, that of the whole must be honourable to the Governor and garrison.

*The DEFENCE of LUNETTS, TENAILLONS, and  
COUNTER-GUARDS.*

**L**UNETTS and Tenaillons are capable of great Defence, on account of their being so near the  
N 3 ravelin



ravelin by which they are defended, and from whence the Besieged may fall several times to retake these works when lost; the prodigious defence which the Tenaillons made at *Lisle* sufficiently proves their utility, the Besiegers having been driven out three several times before they could entirely take them.

The Besiegers are never secure in these works till they are masters of the ravelin; and if the Tenaillons have retrenchments in them, as customary, so well as the ravelin, the enemy can never get possession of them but with the utmost difficulty, and the loss of many men. A brave Governor may make the Besiegers pay dear for taking these works, and prolong the Siege considerably.

It may be observed, that the enemy must bring guns into the Tenaillons to batter the ravelin in Breach, and if the Besieged have any Mines placed so low as water-mark to blow up these Batteries, it will be difficult for the Besiegers to make new ones, especially if the Mines are constructed, so as to throw the guns into the ditch of the ravelin, and when there are guns in the retrenchments of the Tenaillons.

Counterguards before bastions are works of an excellent construction, and may be defended long, because the bastions being so near, they may from thence pour grape-shot, stones, and shells into the Breach, so soon as the enemy appear, and may prevent their making a lodgment there; the guns from the flanks likewise may scower the branches of the Counterguards from one end to the other; so, if there are retrenchments in them, as customary, the Besiegers will find it difficult to take them;  
and,

and as the flanks cannot be battered but from the Counterguards only, the bringing guns over the ditch through the Breach, will be attended with much trouble and difficulty, and may be opposed by many stratagems; and when the Besiegers have at length made their Batteries, they will hardly have room to place so many guns there as the Besieged have in their flanks, especially if they are double: and this is what is aimed at in the construction of Counterguards, since so long as the flanks are not destroyed, the Besiegers dare not venture on the passage of the ditch.

Counterguards placed before the ravelin are defended in the same manner as a ravelin with a redout within it.

### R E M A R K S.

**I**F there are Counterguards before the bastions and Tenaillons joined to the ravelin, and both have retrenchments with revetements, as at *Lisle*, in the front attacked in 1705, the Besiegers will find it hard to get possession of the Place, if it is well provided; since it will be impossible to keep possession of the Breach till the retrenchments are destroyed, which can be done no otherwise than with shells, and during the assault to fling such showers of stones that the Defenders cannot stand them, and as this is the only means by which the Besiegers can expect to succeed, the Governor should provide against it before hand; the manner of doing this, before the Place is Besieged he should consider where the Besiegers must place their Batteries, and place mortars on the ramparts of the Place, and in the ravelin; to know what quantity of pow-

der is required to throw the shells into those Places; which being known, when the Place is attacked, he may destroy the Besiegers batteries whenever they are erected; and as this can be done behind any parapet, and there being no embrasures to discover their situation, they may do their business before they can be fired at, and then they may be removed to some other place, by which it will be a hard task to destroy them.

Tho' I have said, that there should be but 12 mortars in a place of six bastions according to M. *Vauban's* estimate, yet I imagine there should be many more, especially when a place is fortified in the manner here supposed; in my opinion they are full as useful, if not more than guns: since if they are well directed, the Besiegers will hardly be able to keep in their works which are upon the glacis and covert-way, and their situation never known before their effect is felt: whereas on the contrary, guns requires plat-forms and embrasures, and cannot be so easily removed, are generally dismounted so soon as they begin to fire, by the superiority of the Besiegers. It is shameful to see a Place, that cost immense sums to fortify, hold out no longer than they commonly do: if a Prince or a State is at such vast expence to fortify a Place, he ought to know at the same time, that if it is not sufficiently provided with every thing accordingly, he only exhausts his treasures, without an adequate benefit. No man should be Governor of such a Place, but who knows how to defend it to the last extremity, with all the advantages its works will admit or are capable of: but it generally happens that an old officer, who has served a great while, is rewarded with such a post, either because he always behaved well,

well, or knew how to insinuate himself into his master's favour, by a submissive attendance, without considering whether his age renders him incapable of so laborious a task, or whether he has sufficient talents to make a proper defence.

Tho' an officer may have distinguished himself in many actions; yet, if he does not understand Fortification well, and has not a perfect knowledge of the practical part of Artillery, he can never be a good Governor. The great misfortune is, that brave men depend too much upon their courage, and neglect the most essential part of the art of war; or is there any care taken to make them study it, when young; it is thought sufficient, when a gentleman is made an officer, to have courage, and to behave in a genteel manner; how far this custom prevails at present is too well known.

*The* DEFENCE *of* FAUSS-BRAYS.

**T**HERE are but few Places fortify'd with these kind of works at present, besides the Citadel of *Tournay*; since the invention of the ricochet firing, the Defence of them is dangerous, and of no duration; they ought to have many traverses made in them of about 10 or 12 feet thick, and as high as the parapet, to prevent the effect of these ricochets; for which purpose it would likewise be proper to have behind each traverse a kind of shed, covered with strong planks of three or four inches thick, and roofed like a pent-house, that those who defend them may be secure against the ricochets and grenades; but as the enemy will not fail of throwing many shells into the Fauss-bray, it will  
be



be troublesome to screen the defenders against their effects, except there is a ditch of 20 or 24 feet wide, between them and the higher rampart.

All the Defence that such works are capable of, consists in sallying from behind their traverses, to destroy the lodgments which the Besiegers are obliged to make from the lower parapet to the upper one; however, this may be done for some time, if the place does not become too dangerous from the ricochets, shells and stones, in which case it ought not to be defended with obstinacy; the troops may be employed to more advantage in the Defence of the body of the Place.

*The DEFENCE of a Place fortified with TOWER-BASTIONS.*

THE Defence of such Places differs but little from one fortify'd with bastions, only as the counterguards are detached from the body of the Place, they may be defended to the last extremity; and as they are very spacious, admit of several retrenchments, made either in the same form of the counterguards, or in that of the front of a polygon, which being well palissaded, may retard the Siege considerably; these retrenchments should likewise be undermined, that when they can no longer be defended, they may be blown up, to prevent their serving the Besiegers as epaulements against the fire of the Place.

As the bridges of communication made on each Side of the Towers are entirely covered against the Besiegers fire, and the ditch before the towers but narrow, the communication from the Place to the counterguards cannot be interrupted; so that  
after

after all the retrenchments, which these works may admit, are defended and retaken to the very last; the guns placed on the faces adjacent to the towers; which cannot be dismounted by ricochet firing, will do great execution, and may destroy the Besiegers lodgments in such a manner as to be drove out with ease; this may be done, so long as these guns remain unhurt, and which can be effected no other ways than by shells; even then the Governor has it in his power to replace those that are dismounted. The true Defence of such Places, consists in that of the counterguards, and not in the Towers, as authors imagine: since the inner parapet is intirely covered by that of the counterguard, and cannot be enfiladed on account of the towers, as I have observed; and the bridges of communication quite secure; the inside of the counterguards may be defended inch by inch, both above and under ground, with more advantage than any other work whatsoever: and after all this Defence, the place is not open, and the garison may defend the passage over the ditch, and the Breaches made either in the Towers, or adjacent ramparts, a considerable time before they are reduced to capitulate.

To prevent the casemates from being choaked up by the rubbish, a party of men should be sent into the ditch upon floats, if it is wet, so soon as it is dark, to remove it; and to prevent those within the casemates from being stifled with the smoke, some air-machines should be placed in them to drive out the smoak and draw in fresh air; tho' there are several smoak-holes to let the air out, yet they are not sufficient to clear them, unless other means are used for that purpose.

When

When the Besiegers have made a breach in the inner rampart or in the Towers, and finished the passages over the ditch, the Governor may then consider if he is able to sustain an assault ; if he is, he should do it under pretence of making an honourable capitulation, Places have oft surrendered before the Breach in the body of the Place has been practicable ; which should be severely punished, to prevent such treacherous cowardice for the future.

Tho' the *French* Governors are ordered by their instructions, to sustain one assault at least in the body of the Place, yet few have comply'd without being punished : for when *Landau* was besieged by the *Imperialists*, the Governor capitulated so soon, as the Besiegers got possession of the counterguards, tho' the Towers and inner ramparts were yet good and very little damaged. Nothing but the want of every necessary could excuse this Governor, that he was not punished is well known, but what reasons he alledged for his timidity is uncertain.

*The DEFENCE of a Place accessible on one side only.*

THE first thing a skilful Governor should do, is to examine carefully if those sides which are esteemed inaccessible are really so ; whether by some means the enemy may not be able to approach that way ; or if they are not inaccessible, it may be possible to make them so ; if he finds that it may, he should immediately set the garrison to work before the enemy is near to obstruct them ; he should strictly observe whether the enemy can place Batteries on a rising ground so as to annoy some of the works ; in which case, if the ground cannot be levelled, he should

should raise a redout there, to prevent an approach that way. But if these redouts cannot be supported and defended by the works of the Place, cavaliers may be made in the nearest bastions to command that ground. If any part of the Town is surrounded by marshes, rivers, or the Sea, he should consider, if in a dry season they may not be passed over, and take all proper precautions. There are many observations to be made on uneven situations, which cannot be foreseen but by those who live upon the spot, and it is the Governors duty frequently to examine, and consider what may be done to render the Approaches as dangerous and difficult as possible.

A great advantage arising from such a situation is, that the works on that side which is accessible are not to be enfiladed by the ricochet Batteries; and to be attacked in the front only; and as the inaccessible sides need only be guarded by a few men, the best part of the garrison may be employed in the Defence of the works attack; as the troops are in no danger of being cut off from the Place, they may sally out when they please, and oblige the enemy to begin their Approaches at a great distance: the Governor may also construct some redouts or retrenchments beyond the glacis to keep off the enemy, taking care at the same time, that these outworks, when lost, become not a shelter to the enemy, for which purpose they must either be mined, or made so as to be defended and enfiladed by the covert-way. As the Governor is acquainted before-hand which side is to be attacked, he has leisure to prepare every thing for the enemy's reception; that whenever they appear, he may be able to put his designs in execution.

*The*



*The DEFENCE of a Place situated on a high Hill.*

**T**HE Governor should carefully examine the ground about the Place, and if any part of the hill is flat, and not taken in by the works, he should make out-works there quite close to the brow of it; if the avenues leading to the Place are hollow, and there are any places which command them, Batteries should be raised there; and if there are other hills which command any part of the works, a redout, or some other work should be made there, and a detachment put in it. In short, whatever may favour the Approach of the enemy, should either be erased or fortify'd, and this should be done before the enemy appears; as likewise a sufficient quantity of provision for a twelve-month, or longer, should be procured from the neighbouring country, and kept in magazines against the time of a Siege: but, especially water should be taken care of, as generally wanted in such Places; for which reason the Governor should keep the cisterns for receiving the rain-water always in good order, using it with great œconomy, at least when there is any danger of an Attac; and if there are any wells or pumps he should not suffer the inhabitants to spoil them, or to use more water than absolutely necessary: whenever an enemy finds it too difficult to attac the Place in form, he generally turns the Siege into a Blockade, thinking it easier to starve the garrison than to reduce them by force, which however will not succeed, if the Governor has taken the necessary precautions before-hand: add to this, that in winter, or in bad weather, when the enemy cannot  
guard

guard all the avenues so strictly as at other times, care should be taken to make use of that opportunity to bring in corn, cattle, &c. that may be wanted. There are many circumstances arising either from the nature of the ground about the Town, or from the time, season, or opportunity, in which a skilful Governor may provide himself with these necessaries, in case the enemy, after finding all their endeavours to attac them fruitless, should resolve to turn the Siege into a Blockade.

*The DEFENCE of a Place situated near a river.*

**S**UCH Places being generally of great importance, on account of their trade, a Governor should take more than ordinary care to preserve it before an enemy appears; should examine all the parts of the works, and put them in good order of Defence if they are not so: if the river runs on one side, and there is only a fort on the other to cover the bridge, as is usually the case, he should consider whether when the water is low in a dry season, the enemy may not pass along the shore, and insult the Place on that side, and take proper care to prevent them; and if a Battery can be erected on the other side to enfilade any part of the works, or make Breach, which often happens, in that case, some outworks should be constructed to make the Place as strong on that side as on any other. It is to be observed, that the enemy make their Approaches most commonly by the river-side, because one of the flanks of their Attacs is secured thereby; and the artillery, ammunition, and stores, may be brought by water near the place where they are wanted;

wanted; and consequently the Place should be made rather stronger there than any where else; particular care must likewise be taken, that the enemy do not come down the river in boats by night, and surprize it that way.

If there are any islands near the Place, from whence a part of the works may be enfiladed or battered in Breach, as is the case at *Old Brisach* and *Fort Kell*, some works should be made in those islands, to keep the enemy out of them, which is of so much the more importance, as these works seen from thence cannot be enfiladed nor battered from any where else.

If the enemy are careless of their Trenches on the side next the river, the Governor may order some men over in boats in the night, if he has any, to attac and enter the Trenches on that side, and at the same time make a sally on some other part of them. In short, a skilful Governor will know how to make the best Defence, whatever the situation may be, whether it be water, marshes, or dry land.

#### *The DEFENCE of small Places.*

IT often happens in the course of a War, that parties are placed in posts having little or no Fortifications, which serve either to secure the convoys of Ammunition and provision for the Army, or to guard some passes by which an enemy may enter the country, either to raise contribution or plunder it; to hinder parties from approaching either the general camp, or any troops from thence, which are besieging a Place; or lastly, to secure the troops in their winter quarters, for more conveniently

niently drawing them together on any sudden occasion.

An officer, who commands where he may be insulted at any time, should take care to secure the entrance or gate, by a small ravelin made of earth, and turfed and well palisaded, as likewise the gate where he may sally out; and if there are any more gates, they should be walled up.

If the Place has either no ditch, or a bad one, the old should be repaired, or a new one made; and if there are a sufficient number of troops, a covert-way may be added, well palisaded; but if the Place is not worth the trouble, or there are not troops sufficient for that purpose, care at least should be taken to prevent any surprize; the wall should be repaired where it is wanted, and put in order for Defence; all the principal avenues well guarded; small parties should be sent out in the day, to prevent the enemy from reconnoitering the Place; in the night, the patrol should continually be in motion, and no body suffered to approach the gates upon any pretence whatever, to prevent the fixing of a petard.

If there are any round towers near the gate, as is customary, loop-holes should be made flanking the gate, to fire upon any body who should attempt to approach.

When there is any apprehension of the gate's being broke open, either by a petard or other means, and there is no time, or a sufficient number of troops to secure the outside by palisades or out-works, a large pile of dung and earth mixed together should be thrown up against the gate, on the inside, which will diminish the force of the

O

petard;



petard; and every means should be used that can be imagined, to prevent the entrance of the enemy.

The centry placed over the gate should keep a careful watch in the night, that no body approaches unperceived; and if he hears the least noise, must immediately give notice to the guard, that they may be ready to oppose the enemy, in case of any attempt.

The troops should continually watch in the night all round the rampart, or wall, to prevent an escalade, provided with long poles and forks to overthrow the ladders, also with great stones and timbers to roll down upon the enemy; if they have any fire-works of pitch or tar, they should be thrown into the ditch amongst them, to burn or disable them. If these and all other proper precautions are taken, the enemy will not have it in their power to surprize the Place, unless it be done by a great part of the army, and provided with cannon; then it must be left to the discretion of the Commander, whether to wait for the enemy, or retire betimes.

It happens sometimes that a party is surprized in a house, church, or orchard, without having any time to fortify themselves. It is impossible to lay down any certain rules for defending such Places, depending on so many circumstances; it must therefore be left to the capacity of the Commander. All that can be said, at present, on this subject is, that if the house in which he is surprized is covered with straw, or any thing else easily set on fire, he should uncover it immediately, barricade the doors, make holes in the wall, in several places, high and low, to fire through, put some of his people in the garrets; to prevent them entering that way, others in all the rooms of the house; boards of the floors  
above

above should be taken up near the doors, to leave a space of three or four feet wide, to serve as a kind of a ditch to this Fortification; and if there is not a sufficient number to defend all the parts of the house, the lower apartments must be abandoned, and some placed over the doors, to fire down upon those who enter. If ammunition is scarce, they should repel the enemy with their bayonets fixed; and if they find it impossible to maintain their post, they must retire in the night as privately as possible, and all in a body, taking care if they meet with any enemy's by the way, not to fire upon them, but to run them through with their bayonets, for fear of alarming the rest of the body. In this manner the late Count Saxe, with a Party of 18 men only, resisted 800, and he and his party made a safe retreat.

*Precautions which a Governor should use in Time of War.*

**A** Governor should before any Enemy appears, examine the works of a Place, repair those that want it, palissade the covert-way, if not done before, as likewise lay some horizontally on the middle of the Parapets, which have no Revetement; clear the ditches from the mud, see that the gates or entrances are secure and well defended from being broke up; keep strict Discipline and good order in the Town, prevent the garrison from molesting and abusing the Inhabitants; watch narrowly that no Traitors correspond with the enemy to betray the Place; for which purpose, the Governor should have some to whom he may trust, who are to get into companies unsuspected, to hear what passes, and give him notice. If there are any old

aqueducts, or under-ground passages, they should be stopped, and centries placed at their entrances; if there is any river passing through or near the Town, parties must be put into boats in the night, both above and below the Place, to watch that the Enemy do not come that way. In frosty weather the Ice in the ditches should be broke every day, and the shoals laid a-top of one another towards the Place, which make a slippery unpassable wall.

He should send every day, parties of horse and foot, to range in all the principal avenues, two or three miles distance, to prevent any ambush or approach of the enemy, in the night he should take care that the several guards keep strict duty, and watch carefully at their several posts, not letting any one approach the walls, not even the centries, without the forms usual in such cases. The patrol should walk all night about the several posts, to see that the centries do not sleep, and that they listen to hear the approach of the enemy, and on the least noise or suspicion, give notice to the guards, and they to the Governor.

On Fair or Market-days the Gates should be strictly guarded, the horse and foot should be ready to assemble and march upon the first notice; none should pass the gates, but who have some visible business, or can give a good account of themselves; the centinels should not let any coaches, waggons, carts, &c. enter too close behind one another, and when they are loaded with hay, straw, or any other thing, wherein people may be concealed, they should be well examined before they pass; and never permit any carriage to stop upon a draw-bridge, on any pretence whatsoever, to prevent their being drawn up, if occasion requires.

On

On holidays, festivals, or rejoicing-days, the Governor should take particular care, to see the guards kept in the strictest manner, and military discipline observed with the utmost rigour; no great assemblies suffered after dark.

The clergy are the most apt to betray Places, as experience has shewn, the Governor should frequently examine churches and religious houses, to prevent conceal'd persons, or whether they have any under-ground passages leading out of the Town, as sometimes have been. Had the Governor of *Cremona* taken these precautions, he had not been surprized in bed as he was by Prince *Eugene*, who held private correspondence with a priest, that treacherously concealed a body of men in a chapel, and others that were let in to the Town, thro' an old aqueduct.

When the enemy knows that a Governor takes such and other precautions, they will hardly attempt the surprizal of a Place, and should they be adventurous enough to undertake it, it must certainly turn to their disadvantage.

### Of CAPITULATIONS.

**T**HE Capitulation being the last action, both in the Attac and Defence, this is the most proper place to treat of it.

When a Governor, who defends a Place, sees himself reduced to the last extremity, or is ordered by his Prince to surrender, to get better conditions from the enemy, and a more advantageous composition, both for the inhabitants and garrison, he orders to beat the *Chamade*; for which one or more drummers are to beat their drums on the rampart next to the Attac



to give notice to the Besiegers, that the Governor has some proposals to make; there are likewise put up, one or more white colours, upon the rampart, for the same purpose, and one of them remains either on the Breach or rampart, during all the time of negotiation. The same is done for asking a suspension of arms, to bury the dead, and carry off the wounded, after a violent Attac.

The *Chamade* being beat, the fire ceases on both sides, and the Governor sends some officers of distinction to the Commander in chief of the Besiegers, who deliver to him the conditions on which the Governor proposes to surrender the Town. But as a security for the officers sent from the garrison, the Besiegers send a like number into the Town. When the Governor's proposals are not satisfactory to the General of the Besiegers, he prescribes the conditions on which the Town is to surrender; he commonly threatens the Governor to allow him no conditions at all, in case he refuses those proposed, within a certain time, or when such or such a work is finished. If the Besieged find the conditions of the Besiegers too hard, the officers return to their homes, and the drums are beat upon the rampart, to make every body retire before hostility begins, which is done in a very short time after. It is to be observed, that during the suspension of arms, no work should be done on either side, either to secure the Besieged or the Besiegers; nothing should be undertaken during the negotiation, yet it is very necessary to be upon the watch at that time as much as at any other, for fear of being surprized by stratagem, which is now looked upon as lawful.

But let us suppose, that the terms of capitulation are agreed upon; the Governor sends two or three  
of

of his principal officers into the camp, and the General sends the same number, and of the same rank into the Town, as a security for accomplishing the Capitulation. When the Besieged have performed every thing according to agreement, their hostages are sent back; and when the Besiegers have performed every thing agreeable to the agreement, their hostages return.

The conditions of the Besieged may be of various kinds, according to the different circumstances or situations in which they are; the most common ones are,

1. That the Garrison shall march out thro' the Breach, with their arms, baggage, horses, drums beating, matches lighted on both ends, flying colours, a certain number of cannons and mortars, with their appurtenances, spare carriages, ammunition for a certain number of charges, to be conducted in safety to the Town agreed on, and which is usually the next belonging to the Besieged: it must be observed to insert, *by the shortest road*, or the road is specify'd in words, which the garrison are to march. When the garrison have several days to march before they can reach the Town agreed on, it is required that the troops should be provided with provision and lodgments during that time.

2. One of the gates shall be delivered up to the Besiegers, either the same evening, or at a certain hour next day, and the garrison shall march out in a day or two after, according to the agreement made between both parties.

3. The Besiegers shall furnish a certain number of cover'd waggons, that is, which are not to be searched, besides others to carry the wounded and sick, which are in a condition to be transported;

and, in general, all the carriages necessary to carry the garrison's baggage, and the artillery allowed by the capitulation.

4. That the sick and wounded, which cannot be carry'd off, and are obliged to remain in the Place, shall have free liberty to go away with every thing that belongs to them, when they are in a condition to do it; and they shall be furnished, in the mean time, with lodgings and provision *gratis*, or otherwise.

5. There shall be no indemnification required from the Besieged, for horses taken from the inhabitants, or for houses burned or destroyed during the siege.

6. The Governor, the officers under him, and those belonging to the Garrison, the Garrison, and, in general, every one in the king's service, shall freely go out of the Place, without reprisals of any kind.

7. If those who take the Town are of a different religion from that of the inhabitants, it must be inserted in the capitulation, that the inhabitants shall exercise their religion without any molestation.

8. That the inhabitants, and those depending on the Place, shall be maintained in all their rights, privileges, and prerogatives.

9. It shall be at their choice, who have a mind to leave the Place, to go where they please with all their effects. It should be stipulated, that the inhabitants who have shewn any partiality to the Garrison, shall not be molested on that account.

10. It is also mentioned in the capitulation, that all the powder and ammunition remaining shall be delivered to the Besiegers, and the loaded mines are likewise shewn.

11. That

11. That all the prisoners made on both sides during the Siege shall be released.

A Garrison should have provision and ammunition, at least for three days, to be entitled to a composition, without which they are to be made prisoners of war : but if the Besiegers have not inquired into it before the capitulation is signed, it would then be an injustice to make them prisoners of war.

When the Besiegers will agree to no other composition than that the Garrison shall be made prisoners of war, and the garrison is not in a condition to hold out any longer, it is generally endeavoured to make the conditions as little onerous as possible.

1. That the Governor, and the principal officers, shall keep their swords, pistols, baggage, &c.

2. That the subalterns, under the captains, shall keep their swords, with their baggage.

3. That the common men shall not be rifled, or dispersed from their regiments.

4. That the Garrison shall be conducted to a certain Place, by the shortest road, where they are to remain prisoners of war.

5. That the principal officers shall have leave for two or three days to go where they please, to settle their affairs.

6. When the Garrison quits the Place, it shall not be permitted to decoy the soldiers to desert from their regiments.

When the capitulation is settled, an officer of Artillery from the Besiegers comes into the Place, with an officer of Artillery from the Garrison, who take an inventory of all the Artillery and ammunition remaining in the Place ; a commissary of provision



provision enters likewise, to take an account of the provisions.

When it is found necessary to surrender, and that there are considerable magazines stored with ammunition and provision, most of it should be destroyed before any mention is made of capitulating, that there may remain no more than what is necessary, that the enemy may reap no benefit by them. If this should be done after the capitulation is mentioned, the Besiegers may insist on not spoiling them ; but what is already done cannot be avoided.

So soon as the Besieged have delivered a gate of the Place to the Besiegers, the first regiment of the army enters, and mounts guard.

The day on which the Garrison is to leave the Place being come, the Besiegers army is put under arms, and ranged into two files, between which the Garrison passes. The time of marching being come, the General, and the principal officers, head the two files, to see the Garrison defile before them.

The Governor marches at the head, followed by the principal officers, who make the Garrison march in the best order possible. The eldest regiments march commonly the first and last, and the rest in the center with the baggage. When there are any horse, they are also divided into three bodies, to march at the head, center, and in the rear. Small detachments of horse and foot are made, to march at the sides of the baggage, to take care of its not being rifled.

The Artillery allowed by the capitulation march after the first battalion.

When the Garrison is arrived at the Place agreed on, the Governor remits the hostages of the Besiegers

siegers to the escorte; and when the escorte is arrived at the army, the hostages which the Besieged have left for the security of the escorte, carriages, and other things allowed by the army for escorting the Garrison, are released.

When the Garrison are made prisoners of war, they are likewise escorted to the Place agreed on.

Every thing agreed on should be looked upon as sacred and inviolable, and every word should be understood in its genuine sense, without any forced construction; yet as this is not always the case, the Governor should be very cautious not to have any word inserted, but what is clear and plain, without admitting of any other sense than that for which it is used. There are many examples which prove the necessity of this precaution.

In the capitulation of a Garrison, where there is a Citadel, in which the Garrison retires, there are some particular conditions to be requested, such as follow.

That the Citadel shall not be attacked at that side next to the Place; that the sick and wounded, which cannot be transported, shall remain in the Place, and in the lodgings where they are; and after being cured, they shall be provided with carriages and passports, to retire to the place agreed on in the capitulation. No body should be let into the Citadel, but those who may be useful in its Defence; the rest, who are useless, should by no means be suffered to enter. It must be mentioned in the capitulation, that these people shall be conducted to a neighbouring place belonging to their Sovereign, which is to be named. It should also be agreed on, to have a certain time allowed for the Garrison to march into the Citadel; and it should be

be absolutely prohibited that the Besiegers shall make no works whatever, for carrying on the Approaches towards the reduction of the Citadel, during the time prescribed.

A maritime Town requires likewise some particular conditions relating to the Ships which may be in the harbour. It should be agreed, that they shall leave the Harbour the same day that the Garrison leaves the Place, or when the weather permits, to sail to the port agreed on. They keep all their artillery, ammunition and provision, &c. If the bad weather should oblige them to enter any harbour belonging to the Besiegers, it should be mentioned in the capitulation, that they shall be received, and that they shall be furnished with necessaries to continue their voyage; they should be provided with passports, and, in short, all the security possible, not to be insulted by the enemy's ships, till they are arrived at the port specified.

Many other things may be said, with regard to the subject treated on in this work; it would require a larger volume, to enter into every particular; all that has been said should be regarded only as a summary account of the principal attentions which it requires, and what is most generally observed.

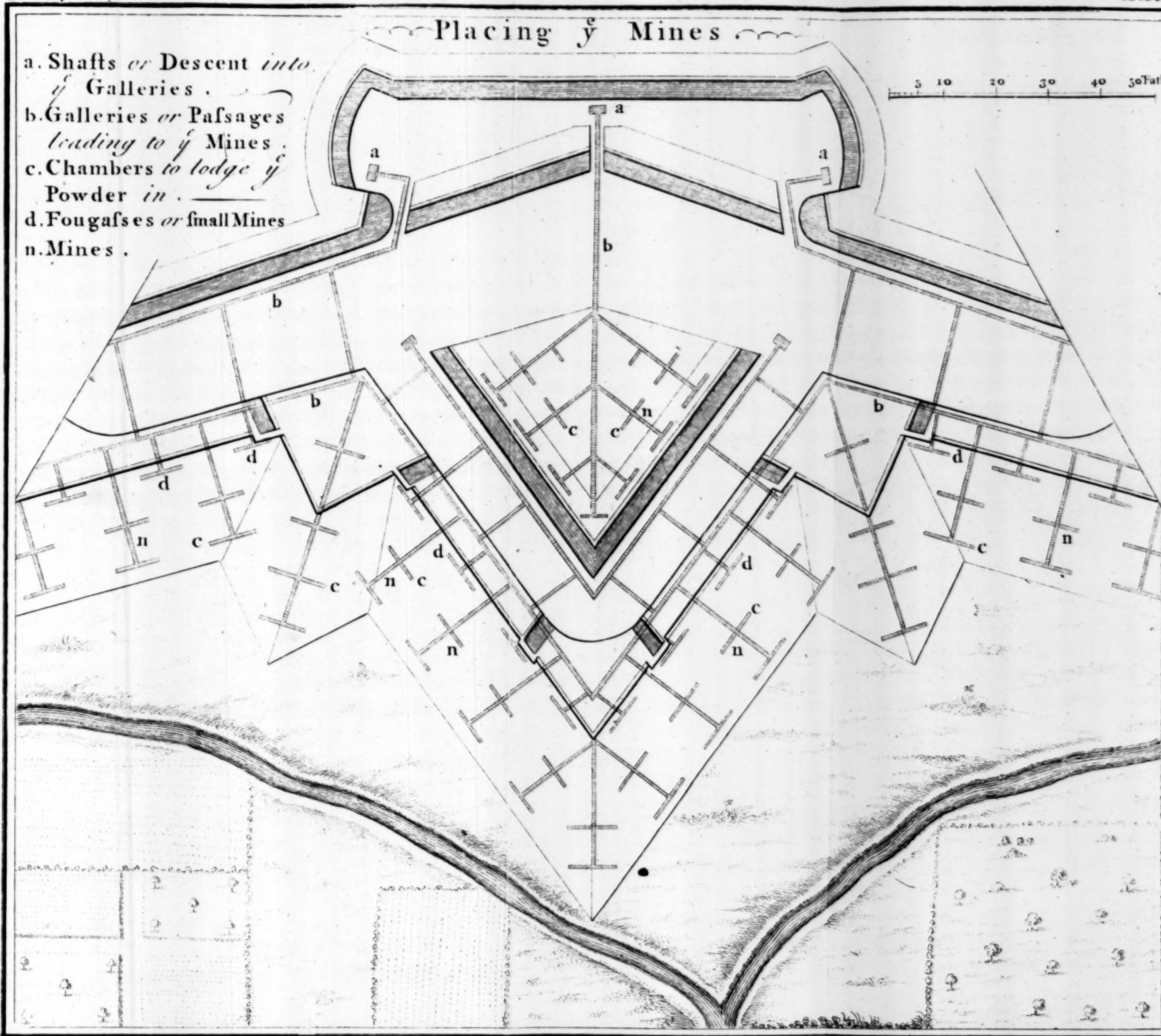
Besides, as a late Author with reason observes, Places have different Defences, according to their situations, and as they are defended with more or less forces, the experience and courage of a Governor should suggest to him the best Defence, to furnish him with resources to repair any accidents that may happen, and to make the best advantage of the Besiegers mistakes and negligence.



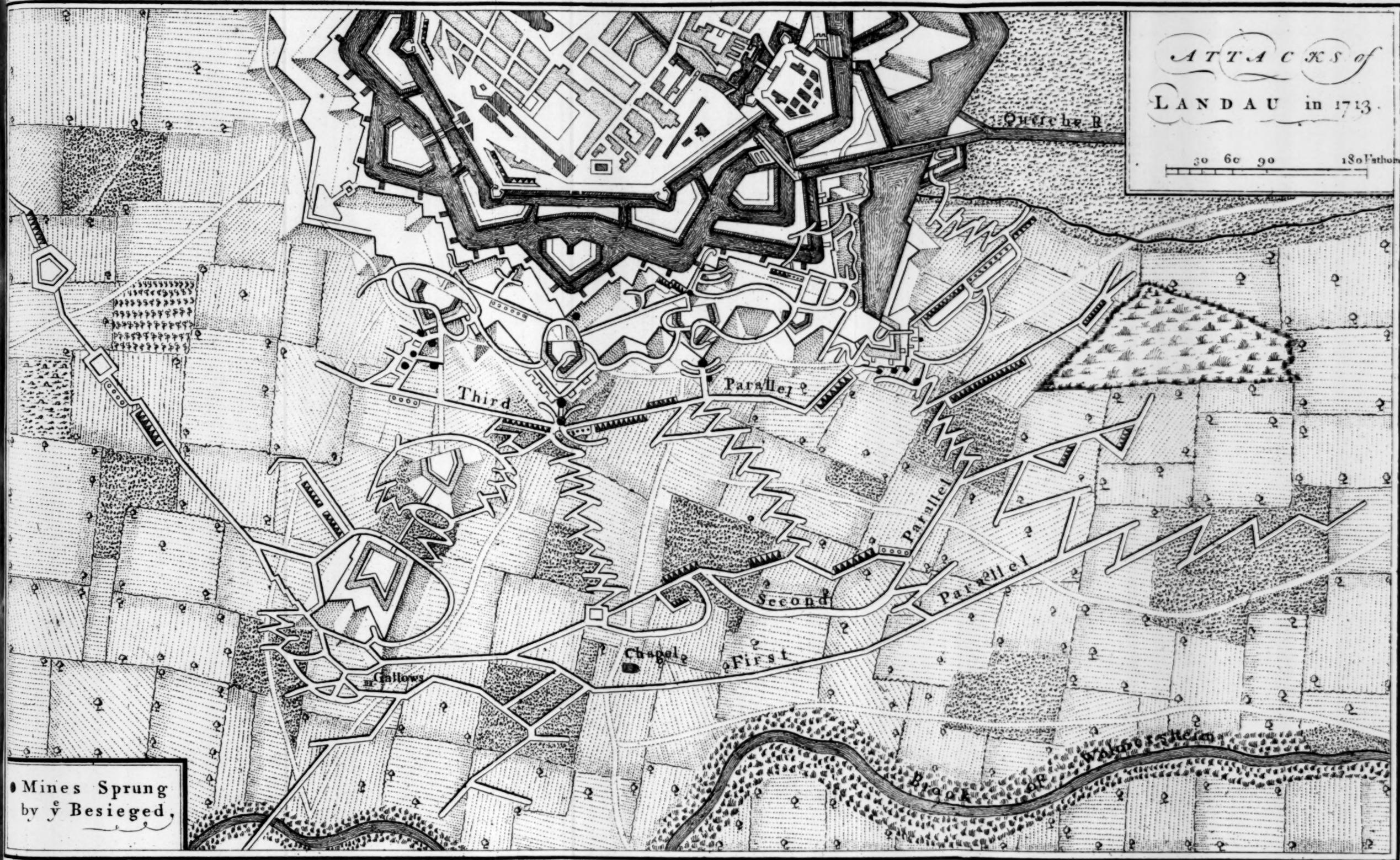
Placing <sup>e</sup> Mines

- a. Shafts or Descent into  
of Galleries.  
b. Galleries or Passages  
leading to <sup>e</sup> Mines.  
c. Chambers to lodge <sup>e</sup>  
Powder in.  
d. Fougasses or small Mines  
n. Mines.

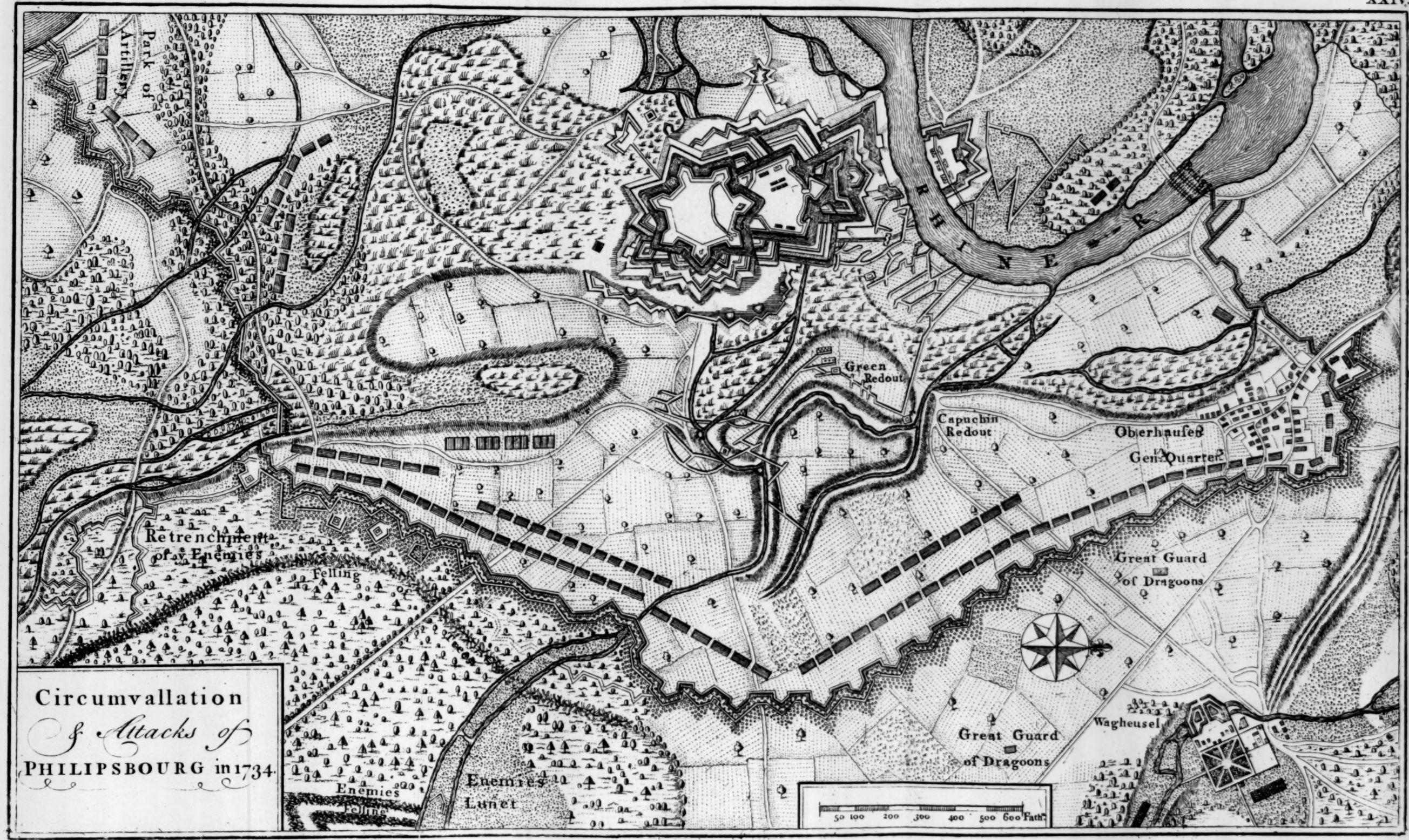
5 10 20 30 40 50 Fath.











It is not sufficient to have courage enough to defend the Place well, it requires besides great sagacity and knowledge, not only in the art of War, but likewise in Fortification.

The Defence is attended with many more difficulties than the Attac, and it may consequently do more honour to a General, who distinguishes himself in it. The superiority over an enemy in an Attac, the conveniencies there is in receiving fresh forces and ammunition, whenever it is wanted, and all other necessaries, which may be had from the neighbouring country; all this may serve to repair any accidents that may happen during the Siege. It is not so in the Defence, no faults are committed unpunished in the face of an understanding enemy. The attention must be equally over the soldiers and inhabitants; keep a strict watch within and without; not to expose the troops without great necessity, but upon such occasions as are visibly useful. In short, the Governor must create a respect from the enemy, by his conduct and sagacity; never give up the least part of the works, till after having exhausted all possible stratagems in the maintaining them. All this requires a great capacity.



A  
T R E A T I S E  
O F T H E  
A T T A C and D E F E N C E  
O F  
F O R T I F I E D P L A C E S.

---

P A R T. III.

---

*Of* M I N E S.

**T**HE Art of Mining is become one of the most essential parts of the Attac and Defence of Places: so much Artillery is used, that nothing above ground can withstand its effect ; for the most substantial ramparts and parapets can resist but a very short time : the out-works, tho' numerous, serve no other purpose than to retard, for some time, the surrender of the Place ; and that advantage is paid dear



dear for, by the great number of troops wanted to defend them, and the immense quantity of stores and ammunition expended.

The object of a Fortification being, that a small number of men shall be enabled to defend themselves advantageously against a considerable army; but if a Place requires nearly so many men to defend it as to attac it, a great expence is thrown away to no purpose, which will ever be the case if it is not countermined.

Whereas a moderate garrison, sufficient to guard the several works, with a company of miners of 60 men, will be able to destroy the Besieged and their works, so soon as they come near or upon the glacis; this they may do at pleasure, provided proper galleries have been made, and that the miners know properly to dispose of the ground. This the Besiegers can only prevent, by carrying on their approaches under ground as well as above, which requires infinite time and labour. They are then unequal to the Besieged; they having their principal galleries prepared before, whereby they are enabled to destroy them and their works, whenever they attempt to come near. Therefore the true art of fortifying depends upon that of mining, as well as the Attac and Defence of Places.

Having explained, in the two preceding parts of this work, every thing relative to all the different works made above ground, by the Besiegers and Besieged; I shall endeavour here to treat as full of those made under ground. I have shewn the use of Mines, and the several stratagems of the miners, it remains to explain the manner of carrying on the Galleries according to a given direction, that of loading them with a proper charge, in respect to  
their

their depth and different tenacities or textures of the soil they are made in, together with the dispositions of the chambers, so as to leave nothing unexplained, and to render the art compleat.

Before I enter upon these particulars, it will not be improper to say something relating to the rise and progress of this art, as likewise to the various opinions of the causes which contribute to their effect, and of the form of the pit or hole they make when sprung. We find in history that Mines were made long before the invention of Gun-powder; for the antients made galleries or under-ground passages much in the same manner as the moderns, from without, under the walls of places, which they cut off from the foundation, and supported them with strong props, then they filled the intervals with all manner of combustibles, which being set on fire burnt their props, and the wall being no longer supported fell, whereby a Breach was made.

The Besieged also made use of under-ground passages from the town under the Besieger's machines, whereby they batter'd the walls at that time to destroy them; which proves necessity to be the inventor of Mines, as of many other useful arts.

Since the invention of Gun-powder, the art of mining has receiv'd great improvements, the work has been much shorten'd, and their effects are become more sudden and terrible; nothing can resist the force of powder, the strongest rocks are not proof against its irresistible force, witness the castle of *Alicant*, which was destroyed by the *French*; and many similar effects are well known thereby to have been produced.

The first Mines, since the invention of Gun-powder, were in 1487, by the *Genoesse*, in the  
Attac

Attac of *Serezanella*, a town belonging to *Florence*; but these failing, they were some time neglected, till *Peter Navarro*, according to *Mr. le Blond*, being then Engineer to the *Genoese*, and after to the *Spaniards* in 1503, against the *French*, at the siege of the castle called *del Ovo*, or Egg, at *Naples*, made a Mine under the wall, and the Governor was summoned to surrender, which not being complied with, he blew up the wall, and the castle was taken by storm.

*Mr. Valliere* relates the same story, but differs in the name of the engineer; for he says, it was one *Francis George*, an *Italian*, who, serving at *Naples* in quality of architect, proposed to *Peter Navarro*, the *Spanish* General, to take this castle by Mines.

Since then Mines were made in the Attac and Defence of most Places: but as the miners had only practical knowledge, this art received but small improvement, till towards the end of the last century; the continual wars at that time in different parts of *Europe*, in which the *French* were generally concerned, induced their miners to make tables for the charges of Mines, according to their depth under-ground. But as they had not sufficient skill to estimate the quantity of earth to be blown up, these tables were very imperfect.

The great engineer *M. Vauban*, was the first that wrote upon Mines, but that art, being then in its infancy, he did not make that improvement which might have been expected from his great genius in the art of war: yet the world is indebted to him, for endeavouring to reduce this art into a science, and to induce others to make farther inquiries: after him succeeded the celebrated *Valliere*, lieutenant

and inspector general of the artillery, who being one of the greatest masters in the art of mining, and joining the theory to a long series of practice, made a great step towards rendering this art compleat. He was sensible, that the pit or hole made in the earth when the Mine is sprung, was not an inverted cone, nor a frustrum of a cone, as supposed by *Vauban* and others before him: by measuring several excavations, he found that it was a Paraboloid nearly; and his tables were computed accordingly to that figure: he also wrote a memoir concerning the Mines made by the Besieged under the glacis and covert-way, with so much knowledge and judgment, that it will remain an eternal monument to his memory. Yet, notwithstanding these several improvements, in the art of mining, it was far from being compleat, as some unthinking authors have lately advanced, there remaining still one great prejudice to surmount, so strongly imprinted in the minds of the practical miners all over *Europe*, that it can scarcely be eradicated by the most glaring evidence. Which is, that the diameter of the pit or hole made by the Mine, was always twice the line of least resistance, or that line drawn from the center of the powder, perpendicular to the nearest surface, and that the before-mentioned diameter, could never exceed twice this line.

The chevalier *Belidor*, formerly professor of artillery at *La Fere*, undertook to remove this prejudice; and tho' he proved by many experiments, that the diameter of the hole made by a Mine may be increased to any length in regard to the depth of the Mine, yet very few miners are convinced of it at this time: it is true that the memoirs he wrote on the experiments made at *La Fere*, had never  
been



been published ; yet most authors have mentioned some parts of them in their works : but as they knew nothing of Mines, having never seen any, they did no more than copy other writers ; they speak of this improvement so as to leave the reader in doubt, whether it deserves to be taken notice of or not. At the same time they give a copy of a dissertation on Mines, published some years since in his course of mathematics, endeavouring to persuade the reader, that it is the most compleat treatise of Mines ever wrote : tho' he acknowledges not to have had sufficient experience when he wrote it, having since found many things inconsistent with truth, begs the reader not to lay any stress upon it.

*Belidor* was present when *Valliere* tried the experiments for discovering the true figure of Mines ; and made some himself upon the same account, yet in his manuscript memoirs, he adopts another method for finding the charges of Mines ; whether he concluded that this figure would not answer all the different problems in the art of mining, or that it was unnecessary to consider the figure at all, is a question I am unable to decide.

The same gentleman made some experiments since by orders from court, concerning a new method for making the Approaches at once, from the extremity of the glacis to the covert-way by Mines, thereby not only to diminish the time and expences of a Siege, but also to save many lives: This and much more may be done by the Besieged, supposing the nature of the ground will admit of digging twenty feet deep without meeting with water. The disposition of the Counter-mines mentioned by *Valliere*, have been esteemed the best that are possible to be made, yet I am certain, that much

more may be done with very little labour and less expence; it appears to me that a common fortification with bastions, ravelins and a covert-way, maybe made so strong by means of Counter-mines, as to render it almost impossible to take it, or at least that if the Besiegers be obstinately bent to take the Place, their loss would be more considerable than their gain.

Those who imagine that the art of mining is brought to the utmost perfection, are greatly mistaken; all that has hitherto been done, depends upon such principles as are derived from practice and common experience, which alone by a nearer inspection will be found insufficient; a theory deduced from the nature and effects of gun-powder, and built upon such mechanical principles as are taught by the mathematics, well supported and confirmed by proper experiments, is the only way to render that art compleat. As no author has connected the theory and practice together, except *Belidor*, and tho' he has freed the art from many absurd notions of the practical miners, yet he could not intirely avoid adopting some erroneous opinions received by his predecessors.

In the following work, will be considered, the two different methods, whereby the charges of Mines are computed, that is, when the pit or hole is taken for a paraboloid, or when the sphere of explosion is used; and by comparing both with the few experiments that may be depended on, the reader will be able to judge, which should be preferred: I shall likewise subjoin M. *de Valliere's* tables, and with regard to Mr. *Belidor's* last experiments, and some particular things, they are things,

things, which for particular reasons, I hope to be excused from mentioning.

# DEFINITIONS.

**B**Y a *Mine* is understood a passage carried under-ground to the Place that is to be blown up, where a lodgment is contrived for the powder, necessary to produce the proposed effect.

The passage leading to the powder, is called the *Gallery*.

The place where the powder is lodged, the *Chamber*.

The line, drawn from the center of the space, containing the powder, perpendicular to the nearest surface, is called the *Line of least resistance*.

The pit or hole made by a Mine when sprung, is called the *Excavation*.

The fire is given to the Mines by a pipe or hose, made of coarse cloth, whose diameter is about an inch and a half, called *Saucisson*, extending from the chamber to the entrance of the gallery, to the end of which is fixed a match, that the miner who sets fire to it, may have time to retire before it reaches the chamber.

To prevent the powder from contracting any dampness, the saucisson is laid in a small trough, called *Auget*, with straw in it, and round the saucisson, with a wooden cover nailed upon it.

The Mines made by the Besiegers in the Attack of a Place, are simply called *Mines*, and those made by the Besieged *Counter-mines*. Both Mines and Counter-mines are made in the same manner, and for the like purposes, viz. to blow up their enemies and their works; only the principal galleries and

mines of the Besieged, are usually made before the town is besieged, and frequently at the same time, that the fortification is built, to save expences. The Besieged generally make a great many small Mines under the glacis, of about 6, 7 or 8 feet deep under-ground only, which are called *Fougasses*. They make likewise another sort, called *Coffers* or *Caissons*, a kind of wooden boxes 3 or 4 feet long, and a foot or 18 inches wide, which they bury 4, 5 or 6 feet under the glacis, and about 4 yards distant from each other.

The whole art of mining consists in the four following particulars, *viz.*

1. In making the galleries and chambers, and securing the earth from falling in, by means of wooden frames or props.

2. In the loading and stopping the Mines, so as to be ready for springing when required.

3. In knowing the proper charges for Mines placed in different soils, or at different depths under-ground, that the effects may answer the intentions for which they were made.

4. Lastly, in carrying on the galleries according to a given direction, to a given length, so as to place the chamber directly under the object to be blown up, at a certain depth under-ground.

These particulars shall be treated of as amply as the subject requires, and each separately according to their order here mentioned.

#### *Of making GALLERIES and CHAMBERS.*

**W**E shall omit the manner of fixing the miner to the wall, to make a Breach, and how to sink shafts in or near the third Parallel, these having been explained in the Attac of Places.

The



The Galleries made within the fortification, before the Place is attacked, and from which several branches are carried to different places, are generally 4 feet wide and 5 high, and the earth supported from falling in by arches and walls, as they are to serve a considerable time; if they were supported with props or frames of wood, they would continually want repairing, which would at length cost more than stone walls; but when Mines are made to be used in a short time, then the Galleries are only about three feet wide and 5 high, and the earth supported with wooden frames or props.

The entrance of the Mine being made, and the direction of the Gallery known, the first miner works upon his knees, whilst another is behind him, to gather up the earth into a basket or wheelbarrow, which he carries or draws out, and throws near the entrance.

If the entrance is a shaft or pit sunk pretty deep, there must be another miner above-ground to let down a small rope, with an iron hook fastened to the end, into which the miner below hangs the basket, then fetches another while the first is emptied.

When the shaft is very deep, and the Gallery pretty long, a capstan is fixed over the shaft for greater expedition, and a couple of baskets are fastened to a rope, wound round the axis of the capstan; that whilst one draws up the other goes down, as water is drawn out of a well with buckets.

The first miner being tired, the next to him resumes his place, and he goes last, they succeed one another thus till all are fatigued, then they

are relieved by an equal number, which is generally in two hours time.

When the first miner digs up more earth than one man can carry off, another stands behind him at some distance, who takes the basket from the first, and carries it to the entrance; and as the length of the Gallery increases, more men are placed in it to carry out the earth; it must be observed, that they are always placed at equal distances from each other, to reach the baskets from hand to hand, and prevent confusion.

The Gallery being carried on some distance, carpenters follow the miners to prop the earth above, if it is not stiff clay or loam, and to prevent its falling in. This is done by placing a piece of wood a-cross the Gallery over-head, and putting a prop or upright at each end, fastened into the ground, then the earth is removed above this piece, so as to slip a piece of deal board over it, which being afterwards supported in the same manner at the other end, will keep up the earth.

Sometimes wooden frames are made, of the size of the Gallery, and placed at proper distances from each other, and then boards are slipped over them; and to make the frames or uprights tight and firm, wedges are drove underneath, otherwise the shaking of the ground arising from the firing of the guns and mortars, or from the springing some contiguous Mines, may occasion the earth to fall in, and endanger the lives of the miners.

Whilst the work is carrying on, the miners use a mason's level, to level the bottom of the Gallery, to keep to the same depth; and when they come to any turnings, they make use of a square to make them

them at right angles; which they likewise examine with their needle and compass.

The Gallery being carried on to the place where the powder is to be lodged, the miners make the Chamber, which is generally of a cubical form, large enough to hold the wooden box, which contains the powder necessary for the charge, the box is lined with straw and sand-bags, to prevent the powder from contracting any dampness.

The Chamber is sunk something lower than the Gallery; if there is room enough to place the box, load the Mine, and buttress the upper part well, it is sufficient. It must be observed, that when the Besieged can raise the water in the ditch, and the Gallery can be incommoded thereby, instead of making the Chamber lower than the Gallery, it must be made higher, otherwise they will certainly let in the water and spoil the Mine.

When the Gallery is very long and narrow, it often happens that the air is so stagnated, that the candle will not burn, and the miners can hardly breathe, which obliges them to come out often in the open air. Many inventions have been used to prevent this inconveniency, some make use of a large pair of bellows, to the mouth of which they fix a leather pipe or hose, of about three inches diameter, which goes from the entrance of the Gallery to the farther end, where the miners work; or else they suspend a Sac made in the form of a funnel, of about two feet diameter above, and three inches below hooped within, at every foot distance, to keep the cloth stretched, and fix a leather pipe to it as before: but this method will, in my opinion, not answer; for the difference between the rarefaction of the air above  
and

and below, is not sufficient to cause a sensible circulation. The best way, is to bore holes upwards to the surface of the earth in a conical form, at every 40 or 50 yards distance: this may partly be done with an augur of several pieces and then widened below: but this cannot always be done, especially when the gallery is made under a high rampart or buildings, and where the enemy may perceive it, who would not fail to throw some stinking composition into the gallery to smother the miners. I have been informed, that a wooden pipe laid from the entrance to the further end will cause a sufficient circulation of air that the miners may work without inconvenience: some affirm, that a fire of charcoal placed at the entrance will answer; this I much doubt, unless a pipe is fixed to it. It should be observed, that when a leather pipe is used, it must be hooped within to keep it open, that the air may have a free passage, otherwise it will never answer the purpose.

*Of loading and stopping the MINES.*

**I**T would appear more regular to treat of the proper charges of Mines, before mentioning the manner of their loading; but as the computing the charge is a disquisition of an important nature, and chiefly depends on mathematical demonstrations, I thought that by treating the practical parts immediately one after another, would not be improper.

The gallery and chamber being ready to be loaded, a strong box of wood is made of the size and figure of the chamber, being about a third or fourth part bigger than is required for containing the  
the



the necessary quantity of powder; against the sides and bottom of this Box is put some straw, and this straw is covered over with empty sand-bags, to prevent the powder from contracting any dampness; a hole is made in the side next to the gallery, near the bottom, for the saucisson to pass through, which is fixed to the middle of the bottom, by means of a wooden peg, to prevent its loosening from the powder; or that in case the enemy should get to the entrance, they may not be able to tear it out. This done, the powder is brought in sand-bags, and thrown loose in the box, and covered also with straw and sand-bags; upon this is put the cover of the box, pressed down very tight with strong props; and to make them more secure, planks are also put above them, against the earth, and wedged in as fast as possible.

This done, the vacant spaces between the props are filled up with stones and dung, serving for mortar, and rammed in the strongest manner; for the least neglect in this work will considerably alter the effect of the Mine.

After this the auget, or wooden trough, is laid from the chamber to the entrance of the gallery, with some straw at the bottom; then the saucisson is laid in it, with straw over it, and so shut with a wooden cover nailed upon it. Special care must be taken in stopping up the gallery, not to press too hard upon the auget, for fear of spoiling the saucisson, which may hinder the powder from taking fire, and so prevent the Mine from springing.

Then the gallery is stopped up with stones, earth and dung, well rammed, five or six feet farther from the chamber than the length of the Line of least resistance.

But

But to prevent the Mine from bursting through the gallery, and to make it have its effect upwards, the gallery is made with one or two turnings, at right angles to each other, and strongly secured with buttresses and planks, and the intervals rammed with stones and earth. It must be observed, that the distance of the gallery stopped up, is to be esteemed in a right line from the chamber, and not according to its turnings.

*Proper Quantities of POWDER to charge MINES.*

**T**HE estimation of the proper quantity of Powder, with which a Mine is to be loaded in any kind of soil, or at any depth under-ground, to produce the expected effect, is the most difficult part of the whole art of mining. The innumerable variety of soils which are to be met with, the different texture or tenacities of their parts, even in soils, which in all appearance seem to be alike, together with the different strata's of sand, clay, stone, chalk, &c. leave hardly room or hope to arrive ever at any exactness in this art, without mentioning the inequality of the strength of gun-powder, which varies no less than the soils.

All that therefore can be expected is, to establish a theory on such experiments, as may be most depended upon, which, if not absolutely true, may at least be sufficiently near, so as to answer in some degree of exactness in practice, and thereby avoid such manifest errors, as many miners have been led into, by experiments made by persons, whose great names cover their little knowledge in the mathematics, without which no true conclusion can be made from experiments.

The

The charging of Mines not only depend on the quantities of earth to be blown up, but likewise on the tenacities or difficulties to separate their parts. Some insist, that the tenacity is to be estimated by the surface of the excavation, as supposing the whole solid to be blown up entire, without any separation of its parts, in which they are grossly mistaken. *M. Valliere* seems to be of this opinion in his writings, and yet does not make use of it in his tables. *Belidor* has insisted upon the same in the discourse of Mines at the end of his mathematical course, but rejects it in his later writings, yet notwithstanding, writers upon Mines insert it in their books as a very good performance; for whoever has seen a Mine sprung, must have easily perceived that all the earth blown up is separated into small parcels, except some lumps, which are not divided, owing to their greater tenacity; and therefore the resistance in the same soil is nearly proportionable to the weights of the quantities of earth blown up.

The quantity of earth to be blown up depends on the figure of the excavation; that known, its solid content may soon be found by geometry; and by weighing exactly a cubic foot of that soil, it would be easily known what weight is to be raised; and by knowing what quantity of powder is required to raise a certain weight, the tenacity of the parts may likewise be found, by making a Mine so as to produce a good effect; and subtracting the quantity of powder, necessary to raise the weight of the solid from the charge of the Mine, the remainder would be the quantity necessary to overcome the tenacity.

Though it seems to be very possible to observe the true figure of the Excavation, by removing all  
the

the loose earth, and measuring the excavation exactly; and this being done in many soils and depths, one may expect to arrive at least pretty near, tho' not exactly, to the true figure.

Yet it is a matter of dispute what that Figure is; it was at first imagined to be an inverted Cone, as  $ACB$ , whose vertex being in the center of the chamber, and the radius of its base  $AD$ , to be equal to its Axis  $CD$ ; but this being found to make the charge too small, they supposed it to be a frustrum of a cone, such as  $AEFB$ , whose lesser base  $EF$ , is equal to the line  $CD$ , of least resistance, and the greater  $AB$ , equal to twice that line: and it is upon this supposition that the miners have computed their tables of the quantities of powder necessary to charge Mines with, which are placed at different depths.

Mr. *Maigrigny*, an engineer of great experience, was the first I know, who made some experiments near *Tournay*, under *M. Vauban*; where he pretends to have found, that when a Mine was overloaded, instead of producing a greater effect, as might be expected, it would only make a hole like a pit; but that a certain quantity of powder would make the excavation a frustrum of a cone, such as mentioned before; and that the radius of the greater base could never exceed the line of least resistance, let the charge be what it will.

This supposition, not to say fiction, is absolutely false and contradictory to the first principles of nature, that the effects are always proportionable to their adequate causes; yet as absurd as this notion is, it is still retained by practitioners and men of knowledge.

This



This is the case of unskilful practitioners, who receive the greatest falshoods for undeniable truths, without examining whether it be an imposition or not; and reason, the greatest gift bestowed upon man, seems to be of no other use than to serve as a vain pretence to knowledge.

How far *Maigrigny* was qualified for experiments of this nature, will appear best by his manner of computing the quantities of earth to be blown up by Mines of different depths; he says, suppose it requires 100 lb. of powder to charge a Mine, whose line of least resistance is ten feet, then a Mine made in the same soil, whose line of least resistance is twenty feet, will require 200 lb. as having double the quantity of earth to raise; whereas these solids are supposed to be similar, and therefore are as the cubes of their axis; that is, the second would require 800 lb. to produce the like effect.

A proof this gentleman had not the least knowledge in geometry, and therefore unable to make any right conclusion, or draw any consequence from his experiments.

*Belidor* endeavoured in vain to shew the falsities of *Maigrigny's* conclusions; he being opposed by all the practical miners, till at last it was resolved by the chief commander of the Artillery at *Lafere*, to make several experiments, to know how far *Maigrigny's* experiments might be depended upon; there were accordingly above 150 Mines made from 1725 to 1730, to many of which I was an eye-witness; the line of least resistance of the first was 10 feet, and the Mine was loaded with 1000 lb. of powder; which was above tripple the charge assigned by *Maigrigny*; and yet  
this

this Mine had such a prodigious effect, as to blow moats or shoals of earth near a mile off.

As this Mine was only intended to prove that the greater the charge of a Mine was, the greater the effect it produced would be; it was no farther examined, it being thought sufficient to convince all present, that *Maigrigny* had mistaken the point in question. After this, seven Mines were made, having all their line of least resistance, 10 feet; and loaded with the following quantities of powder, viz. the first, with 120 lb. second, 160; third, 200; fourth, 240; fifth, 280; sixth, 320; and the seventh, with 360: these Mines being sprung one after another, and their excavations examined, the diameters of their bases were found thus; that of the first,  $22\frac{2}{3}$  feet; the second, 26; the third, 29; the fourth,  $31\frac{1}{4}$ ; the fifth,  $33\frac{1}{2}$ ; the sixth, 36; and seventh, 38.

These experiments being made in presence of many officers of Artillery, convinced all present that none of *Maigrigny's* principles were true, and that no dependance could be had on his experiments. Yet still the miners are in doubt, whether the diameter of the excavation can be made greater than double the line of least resistance, or if the pit or excavation will not become like a well when overcharged.

The next thing taken into consideration, was to find the true figure of the excavation, which we measured accordingly, as exact as possible, and found it to be a paraboloid very nearly; and it is according to this figure that Mr. *de Valliere* has constructed his tables, which are now used by all the miners in *France*.

But

But as he supposes the diameter of the base to be always equal to twice the line of least resistance, they are far from being so complete as he imagin'd, since they contain but one case only; as will be shewn more at large hereafter.

But before I proceed, it will be necessary to observe, that tho' I said that the figure of the excavation was a paraboloid, yet the quantity of earth to be blown up should be estimated by the part ALMB, cut off by a plane, Fig. 3. LM passing through the focus or center C of the chamber, parallel to the horizon AB; the other part LEM, being occasioned by the force of the powder pressing downwards: It is plain, that since the explosion of gun-powder acts every where, and on all sides alike, it must condense the solid under the chamber from L to M, by its pression downwards, so long as it presses the earth above LM upwards; and it cannot be said, that any particle of earth under the horizontal line LM can be drove upwards; consequently, the part ALMB of the paraboloid, will be taken hereafter to express the quantity of earth to be blown up.

To find the content of this solid I shall premise a few of the principal properties of the parabola: 1. That the square of any applicate, as DA, is always equal to the rectangle made by the parameter and the corresponding abscissa ED; 2. That the ordinate LM, passing through the focus C, is equal to the parameter; 3. And that if in the axis ED, produced downwards to K, so that EK be equal to EC, or equal to the fourth part of the parameter, the line CA drawn from the focus to the extremity of any ordinate, is always equal to the correspond-

Q

ing

ing part KD of the Axis, between that ordinate and the point K.

Hence, because of the right angled triangle CDA, the sum of the squares of CD and DA, is equal to the square of CA or its equal KD; and therefore the square root of the sum of the squares of CD and DA, is equal to the line KD. Whence if CD and DA, are given, the line KD and consequently CK or its equal CL will be given likewise: which shews that if the line of least resistance CD, and the radius DA of the base are given, the parameter may be found.

The solid content of the paraboloid is equal to half the cylinder of the same base and altitude: if  $r$  expresses half the circumference whose radius is unity; that is if  $r=1.57$ .

Then because unity is to  $2r$ , or the radius to the circumference as the squares of the radii CL, DA, are to the areas of their circles; we have  $rED \times \overline{AD}^2$ , for the solid content of AEB, and  $rEC \times \overline{CL}^2$ , for the solid LEM; therefore their difference  $rED \times \overline{AD}^2 - rEC \times \overline{CL}^2$ , will express the solid required.

But if  $p$  expresses the parameter LM; then will  $p \times ED = \overline{AD}^2$ , and  $p \times CE = \overline{CL}^2$ ; these values being substituted into the expression of the solid gives  $rp \times \overline{ED}^2 - rp \times \overline{EC}^2$ ; but since  $ED = EC + CD$ ; this value of ED being substituted, gives  $rp \times CD \times CD + 2EC$ , or because  $KD = CD + 2EC$ ; the expression of the solid is reduced to  $rp \times CD \times KD$ .

It is to be observed, that because  $r$  is a constant number, it may be neglected in comparing the solids; and so  $p \times CD \times KD$ , will be the expression  
of



of the solid. And when two excavations are compared together, which have the same line of least resistance CD; the solid will be expressed by the rectangle  $p \times KD$ , which should be observed, because it renders the computation shorter and easier. Hence, if this solid, or the quantity of earth to be raised, and the line CD, of least resistance, are given, the parameter  $p$  may be found; and having the parameter, and the line CD, the equation  $p \times ED = \overline{AD}^2$ , will give the radius AD of the base.

For if  $CD = c$ , and the given Solid ALMB  $= a$ , then because  $CE = \frac{1}{2}p$ , the Expression  $p \times CD \times KD$ , will give  $pc \times \frac{1}{2}p + c = a$ , or  $ppc + 2pcc = 2a$ , and dividing by  $c$ ,  $pp + 2pc = \frac{2a}{c}$ , to which adding  $cc$ , we shall have  $pp + 2cp + cc = \frac{2a}{c} + cc$ ; and the square root will be  $p + c = \sqrt{\frac{2a}{c} + cc}$ .

In the comparing of Mines together, which have the same line of least resistance, the rectangle  $p \times KD$  gives  $pp + 2cp = 2a$ ; to which adding  $cc$ , there will be  $pp + 2cp + cc = 2a + cc$  whose square root is  $p + c = \sqrt{2a + cc}$ .

By means of these equations, all the different problems relating to Mines are easily solved, upon this condition, that we suppose the forces of powder are proportional to their quantities, and therefore the charges are also proportional to the quantities of earth to be raised in the same sort of soil; that is, in soil of the same density and tenacity.

Many authors assert, that the elastic force of powder is greater, in proportion, in larger quantities

tities than in small ones; that is, that the force of two pounds is more than double the force of one; but as the only argument they offer to support this assertion, is that the heat increases in a greater degree, in large quantities than in small ones; and produce no experiments to confirm it: whereas I have proved in my treatise of artillery, page 31, corollary 2. That when the spaces, in which the powder is confined, are as the quantities, the elastic force of powder are equal; that is, they will impel bodies, which weigh in proportion to the quantity of powder, with the same velocity: consequently a double quantity of powder will raise a double quantity of earth, and so on in proportion to the quantities.

Mr. *Belidor* gives another reason for diminishing the charges of mines as the earth to be raised increases, which is, that not only the weight of the earth to be raised, is to be considered, but likewise the pressure of the atmosphere over the surface of the excavation, which pressure being as the base of the excavation, and this being as the squares of the diameters; whereas the weights of similar solids are as the cubes of these diameters; and therefore this pressure being less in proportion, in larger bodies than in smaller, the charges ought rather to be lessened in large mines than in the small. But how far this reason will hold good has not yet been found by experiments; and since those experiments he made at *la Fere*, manifestly contradict this Hypothesis, as will be shewn hereafter, we may venture to conclude, that notwithstanding all that has been said hitherto, in favour of larger mines requiring lesser charges, in proportion to the small, is intirely groundless, and confirm that quantities

tities of powder, will always raise proportionable quantities of earth.

To know the quantity of powder necessary for blowing up of a Mine in a particular soil; several Mines are to be made in it, having their Lines of least resistance equal, but loaded with different quantities of powder, till one is found to have the desired effect.

This being found, the diameter of its base must be measured with great accuracy, as likewise the Line of least resistance should have been very nicely determined; for the least mistake in this Mine, which is to serve as a model to determine thereby the different parts of all the Mines made in the same soil, would cause considerable errors; and when these Lines are determined, the parameter  $p$ , of the parabola, is found by the equation  $KD = \sqrt{AD^2 + CD^2}$ : and having the parameter given, the quantity of earth or solid is found by the solid,  $p \times CD \times KD$ , or by the rectangle  $p \times KD$ , according as the lines of least resistance are different or the same. This solid, and the charge of the Mine, will serve to find the effect of any other Mine made in the same soil when the charge is given; or to determine the charge, so that the diameter of the base shall be of any given length, by means of the equality  $p \times ED = \overline{AD}^2$ . The same being performed in all the different soils, which generally occur in making Mines, will serve to make Mines of any depth, or placed in any soil.

The miners divide the different soils into five species.

- |     |        |                              |
|-----|--------|------------------------------|
| 1.] | } Into | loose earth or sand.         |
| 2.] |        | common midling light soil.   |
| 3.] |        | loom or strong soil.         |
| 4.] |        | potters clay, or stiff soil. |
| 5.] |        | clay mixt with stones.       |
| 6.] |        | all kind of masonry.         |

It has been found, that a cubic foot of the first weighs 95 lb; of the second, 124; of the third, 126; of the fourth, 135; and 160 of the fifth. But as to masonry, it cannot be determined to any degree of exactness, as depending on the different kinds of stones or bricks of which they are made.

It is pretended, that there is nine pounds of powder required to raise a cubic toise of the first kind; 11 of the second; 13 of the third; 15 of the fourth; 18 of the fifth; and 20 or 25 to raise a cubic toise of masonry above-ground, and 35 or 40 for raising the same quantity under-ground.

These are the *French* weights and measures, which being reduced into *English*, give 8 lb. of powder for the first kind of soil; 9.8 for the second; 11.6 for the third; 13.4 for the fourth; 16 for the fifth; 18 or 22.3 for the masonry above-ground, and 31 or 35 for raising the same quantity under-ground.

In the second volume of M. *Vauban's* attac and defence of places, he says, that the following rules never fail.

A cubic toise of common earth requires 14 pounds of powder to be raised.

Stiff sand or loom, which may be dug without being supported, requires 17 pounds *per* toise.

Mixt earth requires 18 pounds *per* toise.

Potters clay or stiff soil, 19 pounds *per* toise.

Fat or stiff earth mixt with pebble stone, 22 lb.

Whet



Whet sand, which cannot be dug without being supported, 15 lb.

These rules of Mr. *Vauban*, make therefore the charges greater than those of later miners. It will not be an easy matter to decide which of them are best, unless by experiments; I would therefore advise the miners always to make a Mine by way of experiment, before they make any for real use.

Supposing these experiments to be made with great care and exactness, it will be no difficult affair to find the proper charge of a Mine, so as the diameter of its base be of any given length; or when that length is given, to determine the charge required.

For example, let it be required to find the diameter of a Mine made in the second sort of soil; which being loaded with 100 lb. of powder, say, if 11 pounds raise a cubic toise, or 216 cubic feet of earth, how much will raise 100 lb.; the fourth term, which is 1964, will be  $= a$ ; and  $2a = 3928$ ; and supposing the line of least resistance CD to be 10 feet, then will  $c = 10$ ; hence the equation  $c +$

$$p = \sqrt{\frac{2a}{a}} + cc, \text{ will give } c + p = \sqrt{402.8} = 20;$$

or  $p = 10$ , and  $EC = \frac{1}{2} p = 2.5$ ;  $ED = 12.5$ ; whence the equation  $p \times ED = \overline{AD^2}$  gives  $10 \times 12.5 = 125 = \overline{AD^2}$ , or  $AD = 11.2$  nearly.

But to shew how far this theory agrees with the experiments mentioned before, I shall suppose the first to be true, and from thence proceed to find what the diameters of the bases of the others will be. All the lines of least resistances of these Mines were 10 feet each, the diameter of the base of the

first Mine was found to be  $22\frac{2}{3}$  feet; so that AD is = 11.33, or = 11.4.  $CD = 10$ ; these values being substituted into the equation  $KD = \sqrt{CD + AD^2}$ , will give  $KD = \sqrt{229.96} = 15.16$ ; and  $2KC = p = 10.32$ ; hence these values being substituted into the rectangle  $p \times KD$ , because the line of least resistance is here always the same, gives  $10.32 \times 15.16 = 156.5$ , for the solid, which must be remembered, because it is the standard number whereby the other solids are determined.

Now if 120 lb. gives 156.5, how much gives the charge 160 lb. of the second for its solid, the fourth term gives  $208.\frac{2}{3} = a$ , and  $2a = 417.\frac{1}{3}$ ; this value, as well as that of  $c = 10$ , being substituted into  $p + c = \sqrt{2a + cc}$ , gives  $p + c = \sqrt{517.4} = 22.7$ ; hence  $p = 12.7$ ,  $EC = \frac{1}{4}p = 3.2$  and  $ED = 13.2$ . Now these values being substituted into  $p \times ED = \overline{AD^2}$ , give  $\overline{AD^2} = 167.64$  and  $AD = 13$  nearly; and as AB has been found by measurement to be about 26, it shews that this computation answers very nearly the experiment.

If as the charge 120 of the first is to the charge 200 of the third, so is the solid 156.5 of the first to the solid of the third; we shall have  $a = 260.84$  or  $2a = 521.68$ ; and as  $c = 10$ , the equation  $p + c = \sqrt{2a + cc}$  gives  $p + c = \sqrt{621.68} = 24.93$  nearly; hence  $p = 14.93$ ,  $\frac{1}{4}p = EC = 3.73$ , and  $ED = 13.73$ ; these values being substituted into  $p \times ED = \overline{AD^2}$ , gives  $AD = 14.32$ , and  $AB = 28.64$ ; which answers nearly the experiment; it was found that  $AB = 29$  nearly.

If we proceed thus with regard to the 4th, 5th, 6th and 7th Experiments, we shall find the diameters of the base to be as follows; that of the 4th,

31.2; that of the 5th, 33.2; the 6th, 35.3; and that of the 7th, 37.4; which answers pretty near the experiments; the greatest difference does not exceed six inches, or thereabouts; which may arise from various causes, as from the line of least resistance being not exactly ten feet; for a few inches more or less may make an alteration; the inequality of the soil, which may be more or less dense, and many other accidents that may intervene in the practice, so as not exactly to answer the theory.

It may not be improper to mention some of the advantages this method has above that which is used amongst miners; one of the principal is, that if it be required to make a Mine of a large opening, in a low ground, where it cannot be dug very low without meeting with water, then they are obliged to make two or more Mines near one another, so as their joint effects shall make the opening required; whereas any opening may be made according to the foregoing principles, let the line of least resistance be what it will.

There are many cases, especially in the Defence of Places, where a great excavation furnishes a convenient lodgment to the Besiegers, which should be avoided, if possible; therefore the business is to make Mines which shall overthrow the Besiegers works, without affording them much covering. This is done by making the line of least resistance but small, and loading the Mine with more powder.

There are other advantages in making the lines of least resistance but small; the shafts and galleries are much sooner made; and several Mines may be placed under one another, by which the same spot of ground may be blown up several times;

times; and as the Besiegers lodge in the hole, so soon as the Mine is sprung, thinking themselves secure, the second Mine will do them more mischief than the first; and the same may be said of the third.

As the places where batteries are made, to make breach in the face of any work, are always known, Mines may be made under them, so as not only to destroy these batteries, but also to make the guns fall in the ditch, and that several times, as at *La Fere*, where the same battery, opposite to a lunet, consisting of two 24 pounders, was blown up three times, one after another, and the guns every time fell into the ditch.

Suppose it was required to make a Mine, in the same sort of soil as that in which the seven experiments mentioned before were made, so that the line of the least resistance shall be equal to the radius of the base, and each of 10 feet, and to find the quantity of powder necessary for its charge.

Because  $AD = CD = 10$ , the equation  $KD = \sqrt{AD^2 + CD^2}$ , will give  $KD = \sqrt{200} = 14.14$ ; hence  $p = 8.28$ ; these values being substituted into  $p \times KD$ , will give 117 nearly, for the solid; then if we say, as the solid 156.5, of the first experiment, is to the solid 117, so is the charge 120 to the charge required, which is 90 lb. nearly. But if it was required to find the quantity of powder necessary to raise a cubic fathom, or 216 cubic feet of this soil; then because  $CD = 10$  has been neglected in the solid 156.5, of the first experiment, as likewise the ratio  $r$ , therefore, the quantity must be multiplied by  $r \times 10$ ; or because  $r = 1.57$  by 15.7, which will give 2457; then if  
we



we say, as 2457 requires 120 lb. of powder, how much will 216 require; and the fourth term, which is 10.5 lb. will be the number sought. From whence it appears, that the soil, in which these experiments were made, was a light sort of soil, somewhat lighter than that which is taken by the miners for the second sort.

Mr. *De Valliere* supposes, in his Table, which I shall insert here, that a Mine, whose line of least resistance and radius of the base being each 10 feet, requires  $93\frac{1}{4}$  lb. for its charge. Now, if it be required to find what kind of soil these Mines are made in, by substituting the number for CD, AD, into the equation  $KD = \sqrt{AD^2 + CD^2}$ , we shall have  $KD = \sqrt{200} = 14.14$ , and  $p = 8.28$ ; now these values being substituted into  $rp \times CD \times KD$ , we shall have  $15.7 \times 8.28 \times 14.14 = 1838$ ; then if we say, as 1838 is to  $93\frac{1}{4}$ , so is 216 to 11. This fourth term will express the number of pounds of powder required to raise a cubic fathom of the same sort of soil, which therefore is the second sort.

The preceding computations have been made of *French* weights and measures, to shew how nearly the foregoing theory agrees with the experiments made at *La Fere*. It remains now to apply it to our own weights and measures; because eight pounds of powder will raise a cubic fathom of earth of the first sort; if we say a cubic fathom or 216 cubic feet is to eight pounds, 1838 cubic feet is to 68.074 pounds, this fourth term will be the charge of a Mine, whose line of resistance is 10 feet as well as the radius of the base: in the same manner are found the charges of the same Mine in the rest of the soils. But the shortest way of computing

# 236      A T T A C   *and*   D E F E N C E

computing tables is to subtract the logarithm of 216 from that of 1838, which gives 9298917; now if to this logarithm we add those of 8, 9.8, 11.6, 13.4, 16; the weight of the powder required to raise a cubic fathom of the different soils, found before; we shall have 1° 83298, 2° 92112, 3° 99435, 4° 05699, 5° 13401, for the logarithms of the charges of a Mine whose line of least resistance is 10 feet and the diameter of the base 20.

## VALLIERE'S TABLE *for the Charges of Mines.*

Length of the Line of least Resistan.	Charge of Powder	Length of the Line of least Resistan.	Charge of Powder.	Length of the Line of least Resistan.	Charge of Powder.	Length of the Line of least Resistan.	Charge of Powder.
Feet.	lb. oz.	Feet.	lb. oz.	Feet.	lb. oz.	Feet.	lb. oz.
1	0 2	11	124 12	21	868 3	31	2792 4
2	0 12	12	162 0	22	998 4	32	3072 0
3	2 8	13	205 15	23	1140 10	33	3369 1
4	6 0	14	257 4	24	1296 0	34	3680 12
5	11 11	15	316 4	25	1558 9	35	4019 8
6	20 4	16	384 0	26	1647 12	36	4374 0
7	32 2	17	460 9	27	1815 4	37	4748 11
8	48 0	18	516 12	28	2058 0	38	5144 4
9	68 5	19	643 0	29	2286 7	39	5561 2
10	93 12	20	750 0	30	2530 4	40	6000 0

By this construction the radii of the bases being always equal to the lines of least resistances, the  
solids

solids are similar, and therefore are to one another as the cubes of their axis; that is, as the cubes of the lines of least resistances. So that taking any one of the charges to be true, the others will be found by saying, as the cube of the axis whose charge is given is to its charge, so is the cube of the axis of any other Mine to its charge.

For example, let the charge  $93\frac{3}{4}$  of the Mine, whose line of least resistance is 10 feet, be given; and it be required to find the charge of any other Mine whose line of least resistance is given, suppose 15: then say, as the cube 1000 of 10 is to the cube 3375 of 15, so is the charge  $93\frac{3}{4}$ ; to the charge required which is 316.4, or 316 lb. 6 ounces, which is 2 ounces more than in the table. In the same manner is found the charge of a Mine whose line of least resistance is 20; or because 20 is double of 10, the cube of 20 will be octuple the cube of 10; and therefore  $8 \times 93\frac{3}{4}$ , or 750 lb. will be the charge for that Mine.

A TABLE

*A TABLE of the CHARGES of MINES according to the AUTHOR'S Theory.*

Diameter.	Charge.	Diameter.	Charge.	Diameter.	Charge.
Feet.	lb.	Feet.	lb.	Feet.	lb.
22	150	42	639	62	1518
24	181	44	711	64	1621
26	217	46	773	66	1741
28	255	48	857	68	1842
30	297	50	946	70	1980
32	344	52	1020	72	2098
34	394	54	1115	74	2243
36	452	56	1205	76	2372
38	502	58	1299	78	2501
40	560	60	1406	80	2648

In this table the line of least resistance is supposed to be always 10 feet, and the charges producing the openings at the sides of them from 22 feet to 80. I suppose that the charge  $93\frac{1}{2}$  of a Mine, whose line of least resistance and radius of the base are each 10 feet, be given, and from thence all the rest are computed by means of these equations,  $KD = \sqrt{AD^2 + CD^2}$ , and  $p \times KD = a$ ; and as I have observed, by comparing the diameters of the bases found by means of these equations, to be rather less than those found by experiments, it is presumed that the diameters marked in this table will not be found less, but rather greater in practice.

If



If we compare the charges of both tables, which should produce the same diameters, or openings, it will be found that it requires 190 lb. less in my table to make a diameter of 40 feet, 1124 to make one of 60, and 3352 less to make one of 80 feet, which plainly shews the great advantage of this theory above that commonly used; and the great quantity of powder saved thereby. If there were such experiments made as could be depended upon in different soils, tables might be constructed accordingly, and for any depths, from 5 feet to 20, there need be no greater; but as there are no such experiments, we must content ourselves, for the present, with that above, which may serve as a pattern to any one who has a mind to construct others.

Having found, by the foregoing method, the quantities of powder with which Mines are to be loaded; it remains now to shew, how to find the bigness of the box to contain it, which are generally made cubical; and as a cubic foot of common powder weighs about 55 pounds, if we say as 55 is to unity, so is any other quantity to its cube; that is, if the given quantity of powder be divided by 55, the quotient will be the cube required; and its cube root will be the length of the side of the box.

For example, to find a cube which shall hold 360 lb. divide 360 by 55; you will have 6.545 for the cube expressed in feet, and the cube root 1.875 feet, or 22.5 inches of that number will be the length of the side of that cube.

Tho' the chambers are usually made cubical, yet when the quantity of powder is pretty considerable, it will be more advantageous to make them flat,

flat, as the bottom of the excavation will afford a larger lodgment, as likewise the line of least resistance, which is taken from the center of the chamber, will be more proportionable to the earth above it.

It would, in my opinion, be proper to make all the chambers of the same height with that of the Mine made for the experiment. In that case, the side of the chamber will be found by dividing the given quantity of powder, by the product of 55 multiplied by the given height, and extracting the square root, which will be the length of the side required.

For example, to find the side of the box which shall hold 360 lb. of powder, whose height is a foot; then because  $55 \times 1$  is 55, and 360 divided by 55, gives 6.5455; whose square root 2.558 feet, or 30.7 inches will be the length of the side required.

*N. B.* It is to be observed, that the box must always be made a fourth bigger than it should be, on account of the straw and sand-bags put in it, to keep the powder from receiving any damage from wet; so that if the quantity of powder be 360 lb. the fourth part of it, which is 90, must be added, and the sum 450 divided by 55, to have 8.1818, whose square root 2.86 feet, or 34 inches, will be the side required.

It may not be improper to observe likewise, that when a chamber happens to be placed on a rock, or any other hard substance, the force or action of the powder downwards, meeting with a great resistance, will be employed in raising the earth upwards; and consequently the effect of the Mine will be much greater than that produced by the  
same

quantity of powder, being placed on a softer substance. Whence if a platform of strong planks or stones were made under the chambers, there would be a lesser quantity of powder required for the charge of the Mine.

If vessels of cast iron were made in the form of the frustrum of a cone, pretty large above, so as to hold the necessary charges of Mines, they may be of great advantage in places besieged; for if they are placed on a strong platform, and strongly buttressed above against the earth, there need be but little of the gallery stopped up; and when the Mine is sprung, the miners may enter the gallery and remove the vessel a little nearer, and load it again; and this may be done several times, so that many Mines may be sprung in the same gallery with very little trouble.

*A TABLE shewing the dimensions of the cube boxes, for holding the charges of Mines, from 50 to 640 pounds, expressed in inches and tenths.*

Charge.	Side.	Charge	Side.	Charge.	Side.	Charge.	Side.
50	12.5	150	18.0	250	21.4	450	26.1
55	12.9	155	18.3	260	21.7	460	26.2
60	13.3	160	18.5	270	22.0	470	26.4
65	13.6	165	18.6	280	22.2	480	26.6
70	14.0	170	18.8	290	22.5	490	26.8
75	14.3	175	19.0	300	22.8	500	27.0
80	14.6	180	19.2	310	23.0	510	27.2
85	14.9	185	19.4	320	23.3	520	27.3
90	15.2	190	19.6	330	23.5	530	27.5
95	15.5	195	19.7	340	23.7	540	27.7
100	15.8	200	19.9	350	24.0	550	27.9
105	16.0	205	20.0	360	24.2	560	28.0
110	16.3	210	20.2	370	24.4	570	28.2
115	16.5	215	20.4	380	24.6	580	28.4
120	16.8	220	20.5	390	24.8	590	28.5
125	17.0	225	20.7	400	25.0	600	28.7
130	17.2	230	20.8	410	25.3	610	28.8
135	17.4	235	21.0	420	25.5	620	29.0
140	17.6	240	21.1	430	25.7	630	29.1
145	17.8	245	21.3	440	25.9	640	29.3

The



The *French* authors pretend that a cubic foot of powder weighs 70 pounds, which is certainly not true, at least with regard to the powder made at present. For I found by repeated trials, that the cube of the axis of an equilateral cylinder, which holds a pound of powder, was 40 cubic inches; and as the content of the cylinder is to that of the circumscribed cube as 355 is to 452, and the cube 40 is to the cubic feet or 1728 cubic inches; as the weight found by the last proportion is to the weight of a cubic foot of powder, which will be found to be 55 pounds.

The *French* foot being to our foot as 16 to 15 nearly, and their pound to ours as 68 to 63; the cube of 16 is to the cube of 15 as 1728 of our inches is to 1424 of theirs; and 68 is to 63 as 55 pounds *English* is to 50.9 pounds *French*: therefore 1424 is to 1728 as 50.9 to the weight of a *French* cubic foot, which will be found to be 61.7 pounds nearly.

*The manner of directing the GALLERIES.*

Suppose a shaft is to be sunk at A, and the Mine to be carried under an object B, and to be of a certain depth; the first thing to be done is, to find the distance AB exactly, either by trigonometry, or by any other means; then the bearing of this line AB with south and north, must also be found exactly, by means of a good needle and compass, which we suppose to be represented by the angle NAB; then the shaft is sunk at A, of about 5 or 6 feet each way, so low as the Mine is to be deep; then the miner directs his gallery according to the given bearing, using a

Fig. 4.

mason's level to carry it on, horizontally; and as the gallery is carried on, he measures it, till he finds himself under the object B, where he places his chamber.

If the object B is either higher or lower than the place A, where the shaft is made, then the excess of the object above or under the place A must be found, and either subtracted or added to the depth of the shaft, and then the gallery is carried on as before.

It may happen that there is an obstacle in the way, such as a rock, water, or a morass; in such cases the gallery must be made with turnings Fig. 5. at right angles to each other, such as from C to D till it is clear off from the obstacle; after this, it is made from D to E parallel to the first part AC; and at E, it is made perpendicular to DE and EF equal to CD; by which means the point F will be in the first direction, in which it is carried on till the sum of the three parts AC, DE, FB, is equal to the given distance of the object B, from the shaft A.

Various cases may happen in the carrying on the galleries, the particulars can neither be foreseen nor described, for which reason I shall leave them to the skill and knowledge of experienced miners.

It is unquestionably of great importance to make the Mine exactly under the object to be blown up; for want of which, much time, labour, and expence will be lost to no purpose; it is likewise necessary to know pretty near how deep the Mine is under the object, that its charge may be rightly determined; if that cannot be known sufficiently near, it will be better to overcharge the Mine than put too little powder in it.

The

The reader may easily perceive that a good miner should be perfectly well skill'd in the practical part of geometry, without which he will never be able to conduct Mines with any degree of certainty; and therefore I would advise those who are desirous to understand this business well, to study geometry first.

MINES of different sorts.

**I**F a Mine has but one chamber, such as A, *Fig. 6.* it is called a single Mine; if it has two chambers, as *Fig. 7.* it is called double; and if it has three, triple, and so on; their names are taken from the number of the chambers.

If a single Mine is made under the rampart, to make Breach, the entrance O must not be opposite to the place where the chamber is designed to be, on the contrary, it should be made on one side or other; and the gallery with two turnings, as in *Fig. 6.* that it may be stopped with more security; and that the distance of the entrance O to the chamber A may be greater than the length of the line of least resistance, otherwise the Mine would have its effect that way: it must also be observed, that the chamber is placed in the middle of a counter-fort, by which means it will make a greater Breach than if it were placed in the earth behind the wall.

When a double Mine is made under the rampart for making Breach, the entrance O, *Fig. 7.* is made as near as can be guess'd, in the middle, between two counter-forts; the gallery being carried quite through the wall in a direct line, turns afterwards to the right and left, in the form of a T; from whence it is also called a T Mine; and the chambers are also placed in the next counter-forts; but exactly at equal distances from the direct gallery:  
this

this double Mine will make a much larger Breach than the single one, and it is for that reason preferred to any other.

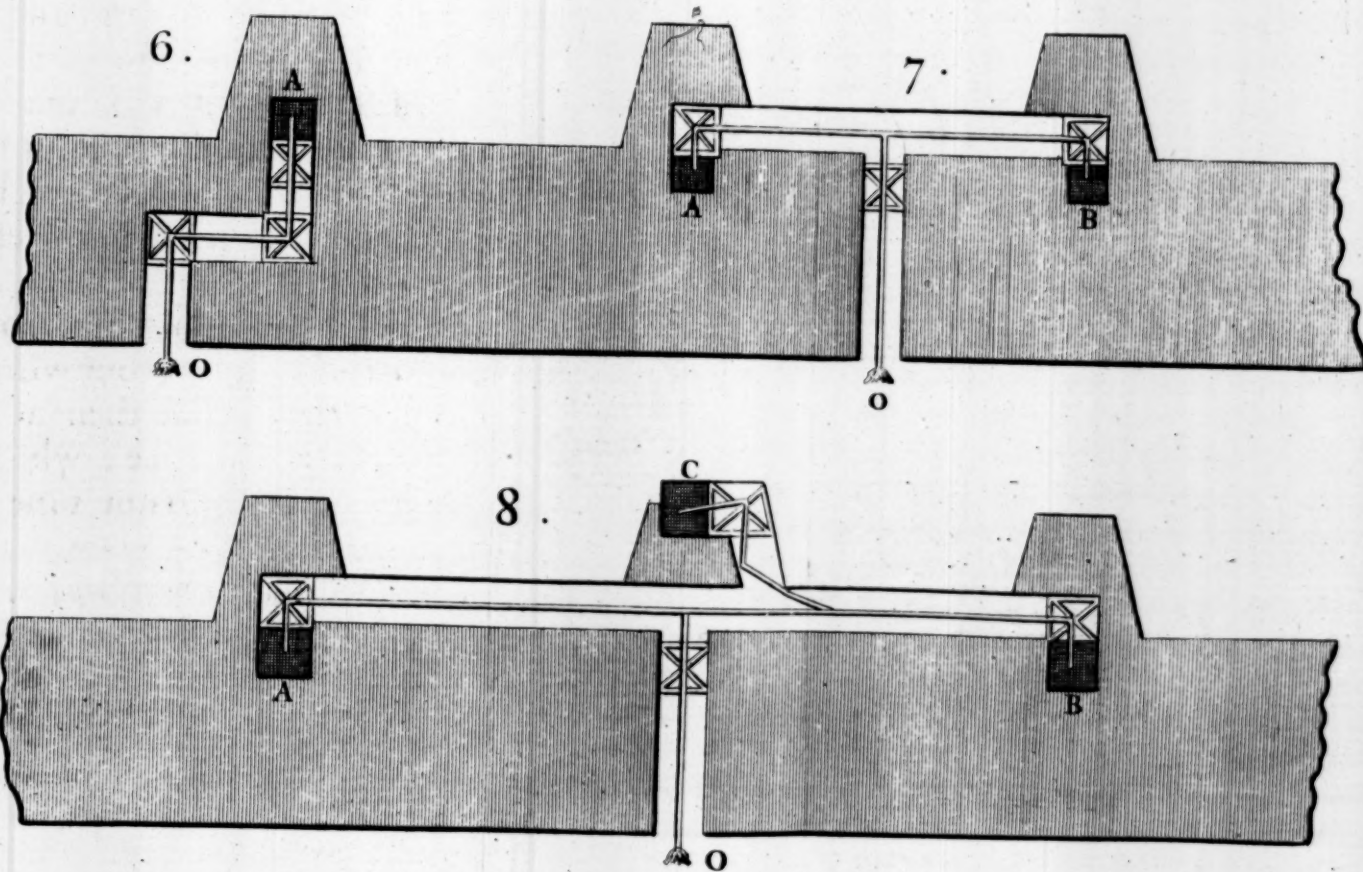
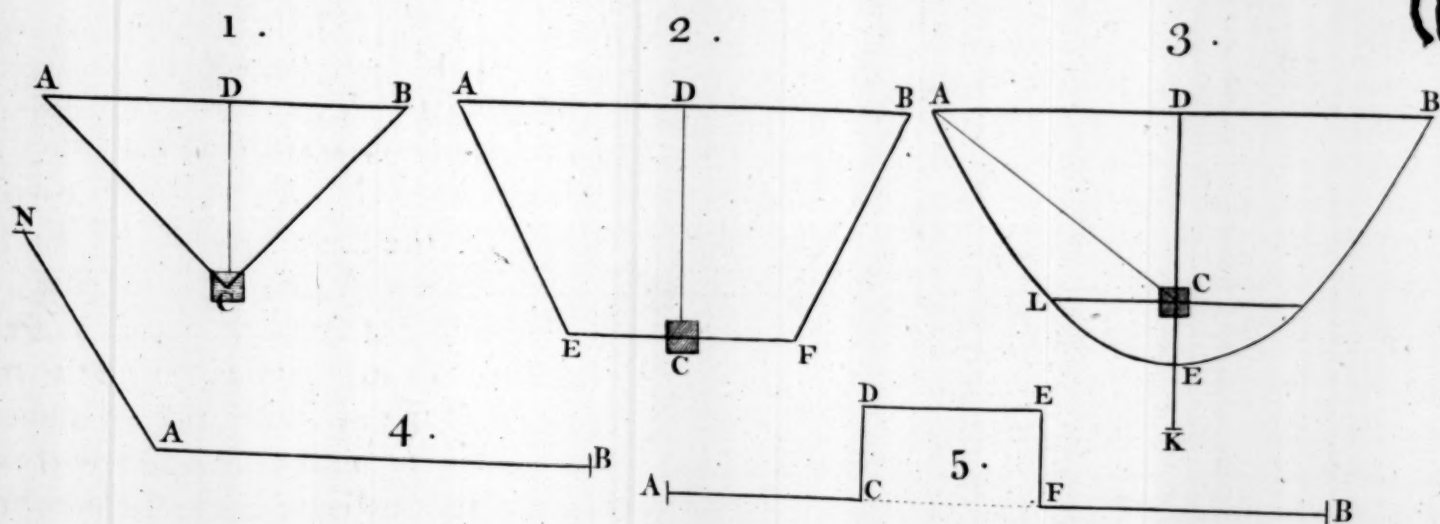
But when a triple Mine is to be made under the rampart, the opening O, *Fig. 8.* is to be made directly opposite to the counter-fort, if possible, and carried directly through the wall, and turned to the right and left in the same manner as the former; and the chambers A, B, at both ends, are placed in the two adjacent counter-forts. As to the gallery of the third, C, it is carried round the middle counter-fort, and the chamber placed under its extremity; this last is generally charged with fifty pounds of powder more than either of the others: but great care must be taken to carry the auget of this last chamber in Zig-zagues, so as to be equal in length to that of the chamber B, otherwise the fire would not reach them all three at the same time, and thereby the chamber C not take fire, which sometimes happens, and then the effect does not answer the expectation.

There are seldom or ever more made than a triple under the ramparts in Sieges; but when a work is to be demolished, they make then as many as will demolish a whole face at once; which is done by giving the fire to all at the same time; that is, all the saucissons are brought into one, and so contrived, as their parts from the chambers to the common junction be exactly equal.

#### R E M A R K.

**T**Hough we have supposed in the Figures 7 and 8, that the entrance O into the galleries is exactly in the middle of the extreme Mines, yet the reader may easily see that it is impossible in practice





tice, since, neither the places nor the distances between the counter-forts, can be seen or known from the outside of the wall: therefore it can only be guess-work; but when the wall is pierced, the gallery must be carried to the right and left, till the counter-forts are found; and then, if the distance to one is greater than the other, the auget and saucisson of the nearest must be made in a Zig-zague, so as to make it equal in length to that which is farthest. In all places fortified by Mr. *Vauban*, the distance from the center of one counter-fort to that of the next, is always 18 feet, when the revetement is as high as the rampart, or 15 feet when it is not so high; so that when one counter-fort has been found, the distance to the next is known; but in any other fortification this observation is useless.

I have thus given a sketch of all the material parts of the art of mining, and settled the principles on a just foundation, which have not hitherto been done by other authors. They in general transcribe the works of Mr. *Vauban* and other practical miners, not considering, that tho' their works were of great use in their time, when this art was in its infancy, yet they can be but of very little use since there has been so many improvements made; what those wanted is now brought to its greatest perfection. M. *de Valliere* has most judiciously treated the method of making countermines under the glacis, besides what relates to those made by the besiegers, either to avoid or forward their approaches, with more expedition and safety. The experiments made at *La Fere* demonstrate, that what had been done was trivial to what might be done.

*Just published for the Use of the Royal Academy at Woolwich, and for all concerned in the Art of War.*

**M**ULLER's System of Mathematics, Gunnery, Fortification, Artillery, &c. in 6 Vol. with above 100 large Copper-Plates, finely engraved, 11. 16 s.

Vol. I. containing Algebra, Geometry and Conic Sections.

Vol. II. Trigonometry, Surveying, Levelling, Mensuration, Laws of Motion, Mechanics, Projectiles, Gunnery, Hydrostatics, Hydraulics, Pneumatics, Theory of Pumps, &c.

Vol. III. Elements of Fortification, with Remarks on *Vauban*, *Coehorn*, *Bellidore*, &c. second Edition improved.

Vol. IV. Practical Fortification, Theory and Dimensions of Walls, Arches and Timbers; Properties, Qualities and manner of using Materials; of facing a Fortress, to estimate the Works, to build Aquatics, as Stone-bridges, Harbours, Quays, Wharfs, Sluices and Aqueducts.

Vol. V. Artillery, general Construction of Brass and Iron Guns for Sea and Land, their Carriages; Mortars and Howitzes, with their Beds and Carriages; Dimensions of all other Kinds of Carriages in Artillery. Exercise at Home and on Service in a Siege or Battle, its March, Encampment, Ammunition, Stores and Horses, Laboratory Works, Theory of Powder, &c.

Vol. VI. Attac and Defence of fortified Places: Preparations for and Operations of an Attac; and the Defence of every Part of a Fortification. Making and loading of Mines, with Tables of their proper Charges. The Dimensions of the Cubic Boxes for holding from 50 to 640 lb. of Powder for their Charges, on a new Theory. The second Edition corrected, and very much enlarged with new Tables, &c. by the Author.

A System of Camp-Discipline, Military Honours, Garrison Duty, and other Regulations for the Land Forces, collected by a Gentleman of the Army; in which are included *Kane's* Discipline for a Battalion in Action. With a Map of the Seat of War, Lines and Plans of Battles, and above sixty Military Schemes, finely engraved from the Originals of the most eminent Generals, &c. To which is added, General *Kane's* Campaigns of King *William* and the Duke of *Marlborough*, improved from the late Earl of *Craufurd's* and Colonel *Dunbar's* Copies, taken from General *Kane's* own Writing. With his Remarks on the several Stratagems by which every Battle was won or lost, from 1689 to 1712. The second Edition continued from the Restoration where our Standing Army commences, in a Series of Historical and Chronological Facts of the Military and Naval Transactions of *Great Britain*; being a concise History (to supply the Scenes of Action in which the General was not engaged) to 1757. By an Impartial Hand. London, printed for *J. Milnes*, opposite the Admiralty Office, 1757. Price 7s. 6d.

A Regimental Book for Commissioned, Non-commissioned, Staff and Private Men, &c. with all Sorts of Books, Returns, Forms, &c. relating to the Army.



11